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PUBLIC WORKS

City, County and State

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JUNE, 1934

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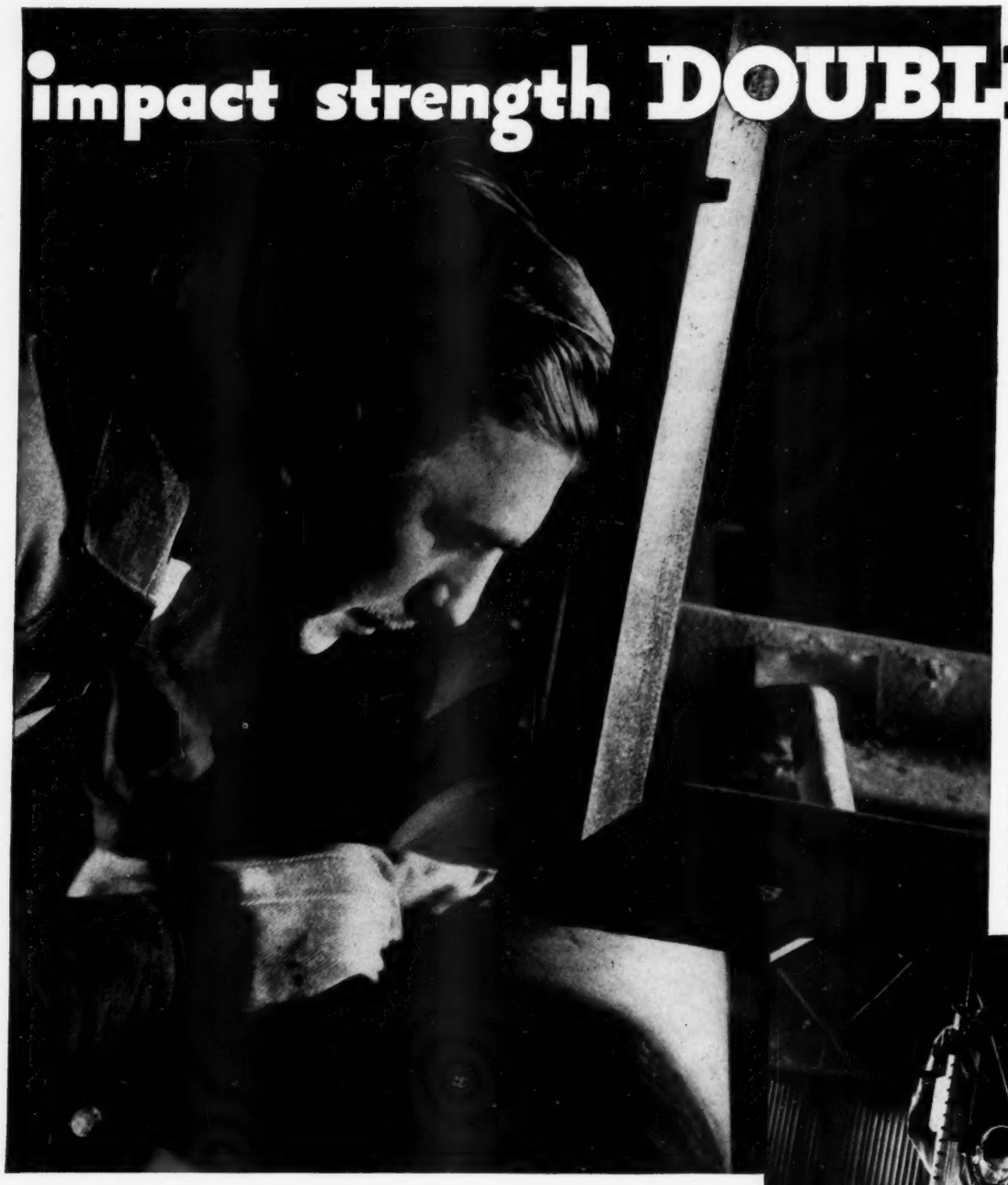

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VOL. 65 PUBLIC WORKS No. 6

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JUNE, 1934

June 1934

PUBLIC WORKS

Vol. 65 No. 6

CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

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TIME-WASTERS

June is the month for conventions, as well as for brides, so to keep convention-goers busy while the speakers drone on, we are giving our readers an extra portion this month—for better or for worse.

Fair and Colder:

Says *Walter S. Wheeler* "I have three correct-reading thermometers—Fahrenheit, Centigrade and Reaumur—in a row on the barn. One afternoon the F registered *plus* X degrees. That night the C registered *minus* X degrees. Next morning the R registered *minus* X degrees, at which time the sum of the R and F readings equalled the C reading." Compute the nine exact readings with their proper signs.

(We don't like the trend of this problem. If we let these problems get out around the barn, someone is going to spring that one about the cow, the rope and the silo.—ED.)

The Florida Chord:

Given a circle of unit radius, with a chord cutting off a segment whose area is one-third the area of the circle. How far is the chord from the center of the circle?—*O. J. Semmes, Jr.*, City Engr., Pensacola, Fla.

"Two" Simple:

A boy is sent to the spring to fetch exactly seven gallons of water, and is given a 5-gallon and a 3-gallon container with which to measure and carry the water. How does he do it?—*Robert N. Clark.*

Ikey & Mikey Sell Watches:

Ikey and Mikey formed a partnership to sell dollar watches, for which they paid a price of more than 30 cents each. One hundred watches were sold and then they decided to divide the profits equally. Each paid for the watches he had sold, and changed his profits (which came to an even number of dollars) into as many $5 bills as possible, and the balance in $1 bills. They then prolonged the pleasure of dividing the profits equally, as follows: Mikey (who had sold the greater number) gave Ikey one-seventh of the difference of their respective profits, then one-sixth of the remaining difference, then one-fifth, one-fourth, one-third and one-half, successively, of each succeeding difference, each payment being made exactly, and without using any change. Eleven bills changed hands during the six transactions. How many watches did each sell and what was the purchase price?—*A. Prescott Folwell.*

Solutions and Notes:

Several interesting solutions to the trisection problem. Not enough room to present them here so they will appear in the regular columns of PUBLIC WORKS (see page 34.) A difference of opinion on the SAP can. Walter Wheeler used the prismoidal formula, about the application of which we have our "doots." His answer was 857 cubic inches. Bob Clark sends in a solution showing 901 inches, along with a bill for the paper used. (It doesn't do him any good). Yep, the commuter walked 50 minutes. No matter how far away or how near the station, it just figures that way. More about the sap can next month. W. A. H.

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A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

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Pages 28, 60 and 61 contain descriptions of many helpful booklets—Don't forget to look them over.

PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 65 *June, 1934* No. 6

Water Works of the Greater New York Metropolitan District

NEARLY one tenth of the population of the United States lives in the New York Metropolitan District, which includes Northern New Jersey as well as Westchester Co. and Western Long Island; and nearly 100 percent of these receive water from public water supplies. The plants serving these vary in size from a small well or impounding reservoir serving a village of a few hundred, to the mountain supplies of New York City.

New York City's Supply

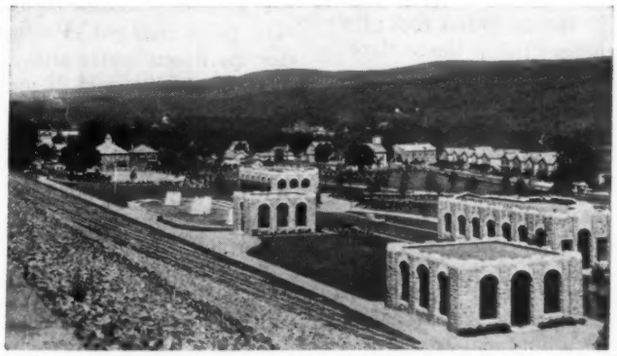
New York City, with a population of something over seven million, uses about 940 million gallons per day, average, or 130 to 135 gallons per capita. Of this total, about 500 million is brought from the Catskill mountains, 277 million from the Croton water shed, 77 million from Ridgewood and Brooklyn Borough, 22.5 million from Queens sources, 8 million from Richmond sources; and 57 million is furnished by private companies. Between 20 and 25 mgd. is sold to other municipalities in Westchester County.

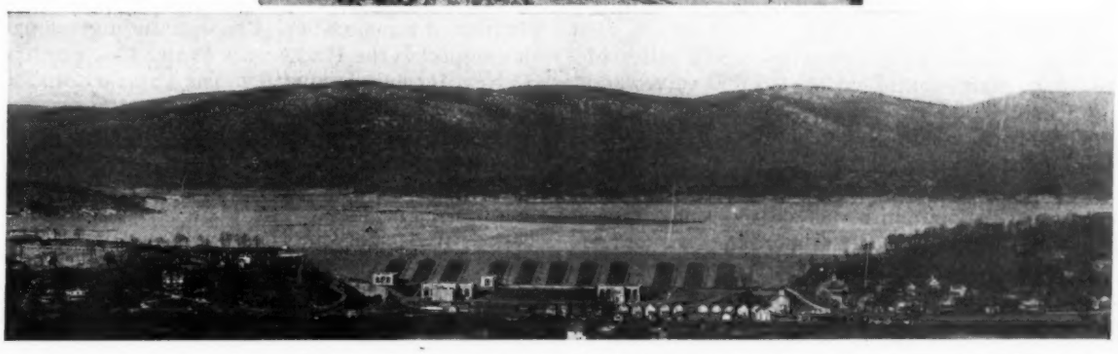
Of the supply used in Greater New York, Manhattan Borough uses about 380 mgd; Brooklyn, 266 mgd; Bronx Borough, 150 mgd; Queens, 116 mgd, and Richmond, 25 mgd. Catskill water is the chief supply for all of these except the Bronx, which derives about 60% of its consumption from the Croton. Manhattan uses the Croton as a supplementary supply; Brooklyn, Queens and Richmond each use supplementary supplies obtained locally.

The Catskill supply is obtained from Schoharie and Esopus creeks with water sheds of 314 and 257 square miles respectively. The former is collected in a reservoir of 19,583 million gallons available capacity, from which it flows through an 18.1 mile tunnel into Esopus creek, and both flow into Ashokan reservoir, with an available storage capacity of 130,428 million gallons. Thence it flows through 81 miles of aqueduct to Kensico reservoir, in the Bronx and Byram water shed. (See map.)

The Bronx supply is derived from the Bronx and Byram rivers (22 square mile watershed) and joins the Catskill supply in the Kensico reservoir, available storage capacity of 30,573 million gallons. From this reservoir water is conveyed through the Catskill aqueduct 17 miles to Hillview reservoir, just north of the city line, which holds 900 million gallons and serves as an equalizing reservoir for the distribution system.

The water collected in Kensico reservoir is delivered to all boroughs of the city by gravity, and is calculated for a dependable minimum yield of 150 mgd. The Catskill is the least expensive of the several supplies to operate and is therefore used to the limit of its de-





Wanaque reservoir and Raymond dam. ABOVE, *control and administration buildings, fountains and landscaping, viewed from top of Raymond dam.*

pendable yield, supplemented by the others where and to the extent necessary.

The next largest supply, the Croton, (the main supply before the Catskill system was constructed) is drawn from the Croton river, 375 sq. mi. watershed in Westchester and Putnam counties, collected in twelve reservoirs and six controlled lakes having combined available storage capacity of 103,100 million gallons. The estimated dependable yield is 300 mgd. Approximately 135 mgd is used as a gravity supply; but the rest is pumped to reach the higher ground in the Washington Heights section of Manhattan and the intermediate service areas of Manhattan and the Bronx.

In Ridgewood and Brooklyn Borough, on the south side of Long Island, water is obtained from small ponds, 2 infiltration galleries and 14 driven wells. Since 1930, about 12 mgd has been pumped from 5 wells constructed by the Layne-New York Company, while 2 more will be used on completion of an iron removal filter plant. The cost of this water, including fixed charges, is estimated at $28 per million gallons. Surface and ground water is obtained for this system in Nassau County, but the State Water Control Commission in 1932 ruled that the city could not increase its supply derived from these sources. The ground water here is receding and in many places is below sea level. There is a draft on it for industrial purposes of about 50 mgd and a law of 1933 places all commercial wells under the jurisdiction of the Conservation Commission.

In the island borough of Richmond, about 8 mgd is obtained from driven wells to supplement the Catskill supply, which is brought to the island from Brooklyn through a subaqueous main.

Six private water companies, drawing their supplies from driven wells, furnish some 60 mgd to different sections of Brooklyn and Queens Boroughs, under the general regulation and control of the Commissioner of Water Supply, Gas and Electricity of the city.

The Catskill supply is distributed through the city by means of a tunnel 17½ miles, driven to a depth which will give a cover of at least 150 feet of sound rock; the general depth being 180 to 300 feet below the surface; but is 450 ft. below the Harlem river and 730 ft. below East River. Twenty-two vertical shafts connect the tunnel with the distribution system, thirteen containing one 48 in. riser each, six containing two 48 in. risers and three with 72 in. risers.

A second tunnel (New York City aqueduct No. 2) 20 miles long and 400 to 700 ft. deep, is under construction. It was holed through Feb. 22nd, 1932. The city has just received from the Federal government allotment of $1,000,000 PWA funds for purchasing and installing valves and other equipment for putting it into service.

The distribution system comprises 4,554 miles of 4 in. to 72 in. mains controlled by 117,660 valves and feeding over 600,000 service pipes (of which 152,700 are provided with meters) and 68,780 fire hydrants. In addition the city has three independent high-pressure fire service systems with five pumping stations, 178.5 miles of distribution mains and 4,291 hydrants.

Since 1925 all pipe 30 inches or more in diameter has been made of ½-inch steel (no cast iron has been used for these sizes), the longitudinal joints electrically welded, riveted or lock-bar, the circumferential joints riveted. For services to buildings up to 2-inch, lead brass or thin copper is used; above 2-inch, cast iron or extra-heavy galvanized. The soils in New York cause comparatively little corrosion, but Catskill water is very active on iron. For all water supply lines within the subway structures under 2½ inches diameter, standard red brass pipe is used, and extra heavy brass for services from street mains to valves in the subway.

All water before delivery to the distribution system is treated with chlorine; and in addition the Catskill water is aerated to free it from gases and in some cases of microscopic organisms. Algae in reservoirs are destroyed by treatment with copper sulphate. None of the supplies is filtered.

The construction of the municipal works has cost about $460,000,000. Maintenance and operation cost about $8,500,000 a year and interest and sinking fund charges, about $16,900,000; which are just about met by the revenue from the sale of water.

Westchester County

Westchester County has a population of about 500,000, of which somewhat over a half are served by municipally owned plants and the balance by privately owned; and part of the water supplied by the latter is purchased from New York City's municipally owned supply. Sixteen municipally owned plants serve 35 communities. Ten private plants serve 27 communities, of which 9 are served by the New Rochelle Water Co. During the past ten years the properties of the New York Interurban Water Company have been purchased by the six municipalities served; the concluding purchase being made in June 1927 by the municipal "Westchester Joint Water Works No. 1," operated jointly by Harrison and the town and village of Mamaroneck, under recent State legislation.

The City of New York derives part of its supply from the two largest water sheds in Westchester County —the Bronx and Croton; but in giving permission for this, the State stipulated that the city must sell this water at cost to communities in the county that need it. The price charged is about 7.5 cts. per 100 cubic feet for the Bronx water and 5.0 for Croton water. In 1933 New York City sold 21 mgd to towns and companies of the county. It receives $600,000 to $800,000 a year for water so sold.

Of about 25 mgd that is not purchased from New York City, 20 to 22 mgd is surface water and 3 to 5 mgd is from underground sources, White Plains using about half of the latter.

New Jersey

One of the interesting features of this district is the extent to which private water companies serve multiplicities of communities. The outstanding company in this respect is the Hackensack Water Co., which serves 52 New Jersey communities. The Passaic Consolidated Water Co. serves 10 communities. Six other water companies serve several communities each and 6 serve only one community.

Several of the municipal plants also serve other communities. The Jersey City plant serves 8 communities besides itself, the City of Newark and the borough of Essex Fells each serves 5 other communities. In all, 22 communities are served by the plants of 5 other communities. Ten municipal plants serve only their own

municipalities. The total number of communities in the North Jersey portion of the district is 120; the total amount of water provided is over 300 million gallons per day.

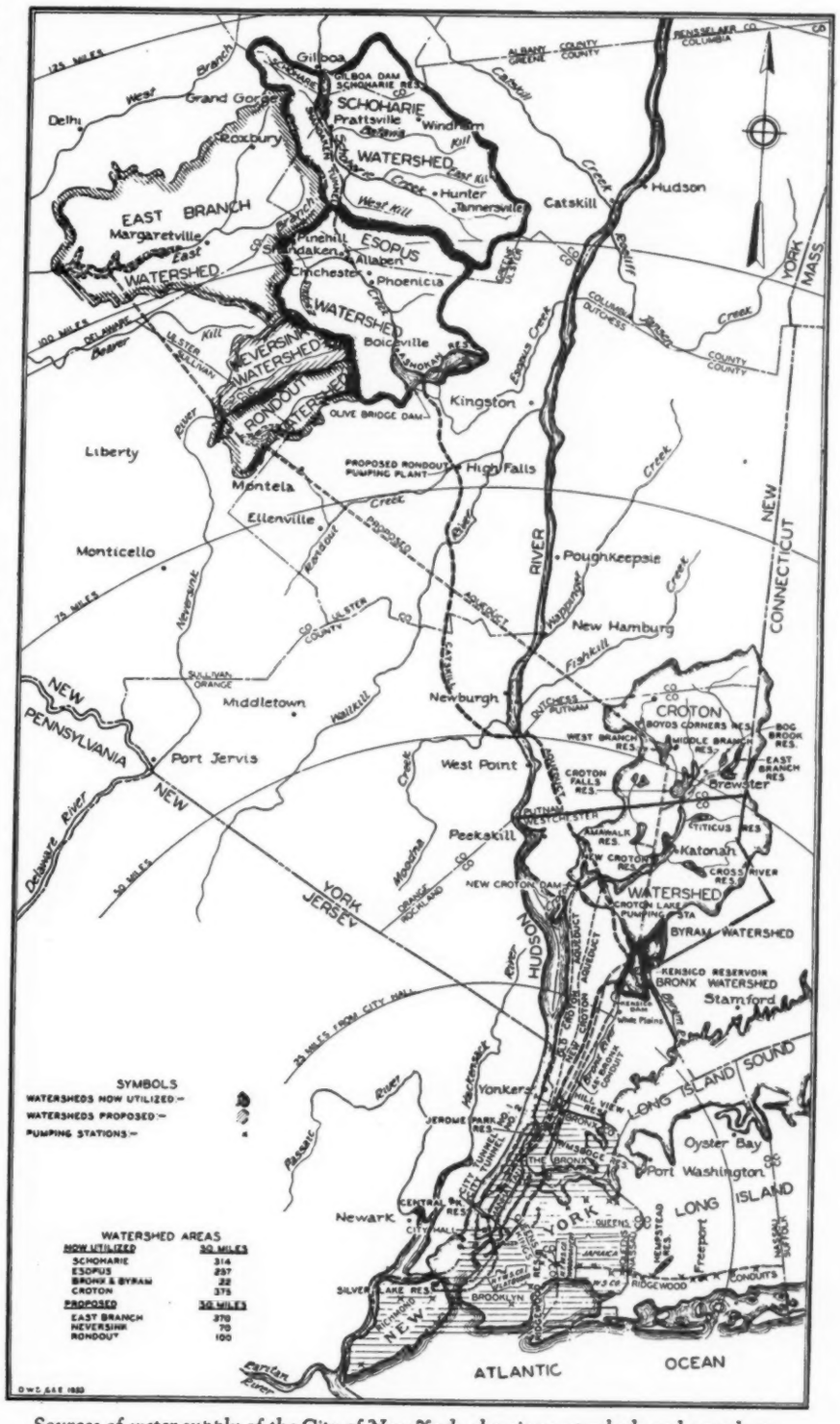
Most of the supplies are from surface sources, about one half gravity and one half pumped, but about 50 mgd is ground water, derived part from the Brunswick formation—soft red shale with sandstone beds; and part from stratified drift—sand and gravel plains, eskers, and deposits of extinct Lake Passaic. The wells are 40 to 700 ft. deep, most of them between 200 and 600 ft., and 4" to 10" diameter. These yield from 120,000 gpd per well down to 2,000.

The largest municipal supply is that of Newark. That city purchased, in 1900, the Pequannock supply, 50 mgd, from the East Jersey Water Co. The city owns 43 of the 63 sq. mi. of the watershed of the Pequannock river, which furnishes the supply. In 1918 the city contracted with State Water Supply Commission for developing the Wanaque supply, to yield 100 mgd; since which several other communities have bought rights in this supply.

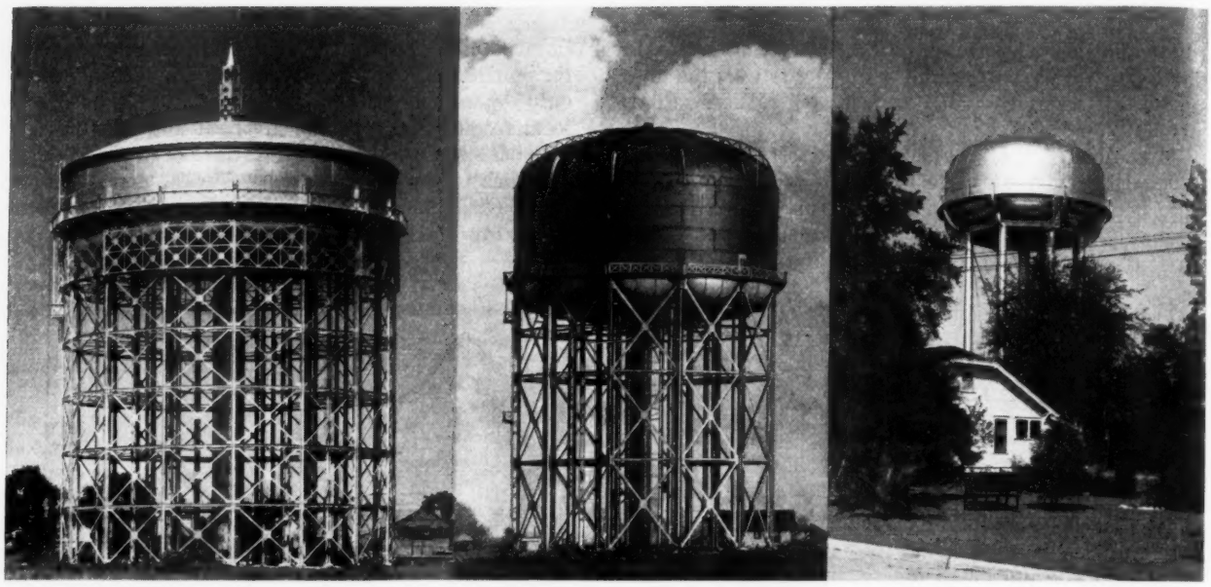
The next largest is the supply of Jersey City, derived from the Rockaway river, which is collected in the Boonton reservoir, with 970 acres area, and yields 70 mgd. Interesting features of this plant are that it was the first in the country to chlorinate water for disinfection. Another is the construction by Jersey City of a sewerage system and unusually complete treatment plant for handling the sewage of five communities which drained into the river above the reservoir, the plant having a capacity of 2 mgd.

The Hackensack Water Co. obtains its supply, about 32 mgd, from surface sources, which total 114 sq. mi. of drainage area, of which the company holds 1400 acres for protecting its supply. Interesting features of the policies of this company are its very complete meter testing and repair shop in which all meters are tested at regular intervals; and its decision several years ago to use copper pipe exclusively for service connections in all the communities supplied.

Altogether, 34 water supply systems serve the three million population; the 8 largest furnishing 90% of the entire consumption; while the smallest furnishes only 1/3 of one percent. After full development, the local resources could furnish about 500 mgd. For additional supply several projects have been proposed, one of which is to drive a tunnel westward across the state to the Delaware River, a shaft under each stream drawing it into the tunnel, and tapping the Delaware at the end.



Sources of water supply of the City of New York, showing watersheds and aqueducts



Evanston tank, capacity 1,500,000 gallons, diameter 104 ft., depth only 25 ft. Height, 117 ft. to high-water line. The required shallowness of the tank was made possible by the radial cone bottom. The ornamental steel work in the top panel of the tower and the cupola were designed by the Evanston Art Commission.

Columbus tank, capacity 2,000,000 gallons, diameter 86 ft., depth 50 ft. Height to high-water line, 125 ft. Part of the ellipsoidal roof is used for tank capacity. The radial cone bottom was used because of the saving in material and cost effected as well as for aesthetic reasons.

Tallahassee, Fla., tank, of Colonial design. Capacity 400,000 gallons, diameter 56 ft., depth 24 ft. Height to high-water line, 102 ft. Part of the roof used for tank capacity. The tower consists of eight 33 in. diameter tubular columns between which no struts were placed.

Designing Elevated Water Tanks

THE designing of water tanks was the subject of a very interesting paper and two discussions at the convention of the Canadian Section of the American Water Works Association, the paper by Prof. C. R. Young, Department of Civil Engineering, University of Toronto, and the discussions by consulting engineers—E. M. Proctor, of James, Proctor and Redfern, and R. O. Wynne-Roberts, of Wynne-Roberts, Son and McLean. The following is abstracted from this paper and discussion.

In designing a tank, the first questions to be settled, generally, are the capacity and height. Mr. Proctor endeavors to design for a capacity equal to 6 or 8 hours' supply. There have been very few breaks in the power service of hydro-electric power supply in Ontario that exceeded this, and such capacity should tide a municipality over a period of power breakage; but an auxiliary pumping equipment is always necessary for fire protection. This size of tank will also allow most of the pumping to be done in off-peak power periods. A good rule is to make the capacity about one-third the daily pumpage; but no small town should build a tank of less than 60,000 gal. capacity.

The height of the tank should be sufficient to give 40 or 50 pounds pressure at the high spot of the town.

The location should be near the center of the maximum consumption of water, even though this is not the highest elevation. Generally speaking, it is cheaper to put a few feet on the legs of the water tower to secure a higher elevation than to run a long pipe line to a higher ground level.

The Canadian Fire Underwriters require a possible pump pressure greater than the tank ordinarily will give, so the tank must be cut off from the supply line during large fires. Every tank should be equipped with an automatic altitude valve with an electric solenoid control for closing the same from the pump house, which valve will shut off the supply to the tank when it becomes full, and the electrical control will close the valve from the pump house in case the pressure is raised for fires. Around the altitude valve there should be a bypass and proper valves so that the altitude valve can be removed for repairs. Hydraulically operated altitude vavles such as the White, Ross, Golden-Anderson and Simplex are available; also a number of valves operated electrically by push button. The top water level may be fixed at, say, a foot below the overflow, and the pumps start again when the water level has been drawn down 5 to 8 feet.

A roof to a tank is desirable to decrease temperature effects; exclude pollution by birds, dust, etc.; and prevent the growth of algae (which sometimes occurs, unsuspected, in tanks as well as in reservoirs).

Type of Tank

Most tanks are of steel, a few of reinforced concrete; only very small ones of wood.

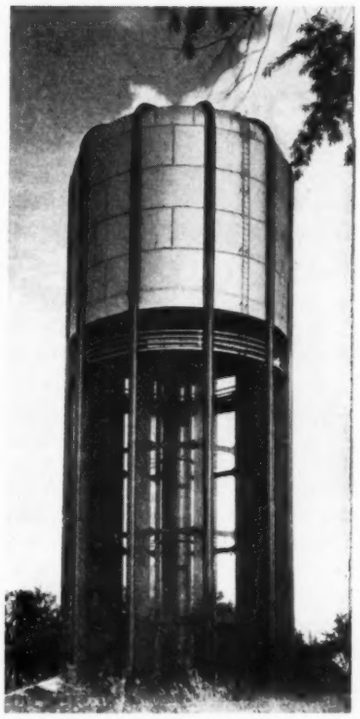
For steel tanks, the suspended bottom has for many years been considered the standard; it saves material, reduces cost and facilitates inspection and painting. Conical bottoms are now seldom used except by railroads using muddy water. For tanks of moderate size, where the question of the variation of head between full and empty tank is not particularly important, the hemispherical bottom continues to be employed. Segmental bottoms possess the disadvantage of the conical bottom in that an inward horizontal component of force is developed at the point where the bottom joins the shell. Even with a hemispherical bottom, if the amount of water in the tank is small the shape of the bottom tends to be so deformed as to produce compressive circumferential or hoop stresses near the point of junction

with the shell. As the head producing such a stress condition is small, however, it is not a governing condition.

One objection to the hemispherical bottom is the need for putting an expansion joint in the riser, which requires regular inspection and occasional repacking.

To minimize variation in head, the ellipsoidal bottom was introduced. This necessarily has large diameter and shallow shell. The flexibility of the bottom permits use of a steel riser, without expansion joint, rigidly attached to the bottom and serving as a column to carry part of the load—how much, it is difficult to calculate. The riser can be made 3 to 6 ft. diameter, eliminating the need of a frost box around it.

Ellipsoidal bottoms in tanks of over 1,000,000 gal. capacity are subject to hoop stresses near the junction with the shell so great that the depth of the bottom must be so increased to reduce them as partly to offset the advantage of this shape. A few years ago George T. Horton devised the so-called radial cone bottom, which involves the use of series of conical troughs with thin apex at the center and radiating outward from the riser to the tank shell. Usually twelve to sixteen troughs are used; by changing the number of troughs or their depths the stresses in the cones can be kept within the desired limits. At their intersections, the troughs are supported by radial girders, each of which is supported by the riser at one end, a steel column at the outer end, and one or more intermediate columns, the columns being so spaced as to bring approximately equal loads to them. Among tanks of this type are one of 2,000,000 gal. capacity at Columbus, O.; of 1,500,000 gal. and 104 ft. diameter at Evanston, Ill., and Indianapolis, and smaller ones at Brooklyn, N. Y., Sandusky, O., Towson, Md., and Tallahassee, Fla. In the Columbus and Tallahassee tanks the water rises into the domed roof, 12 feet above the shell in the former and 7 feet in the latter. The Towson and Tallahassee tanks also have novelties in the way of bracing and column forms.

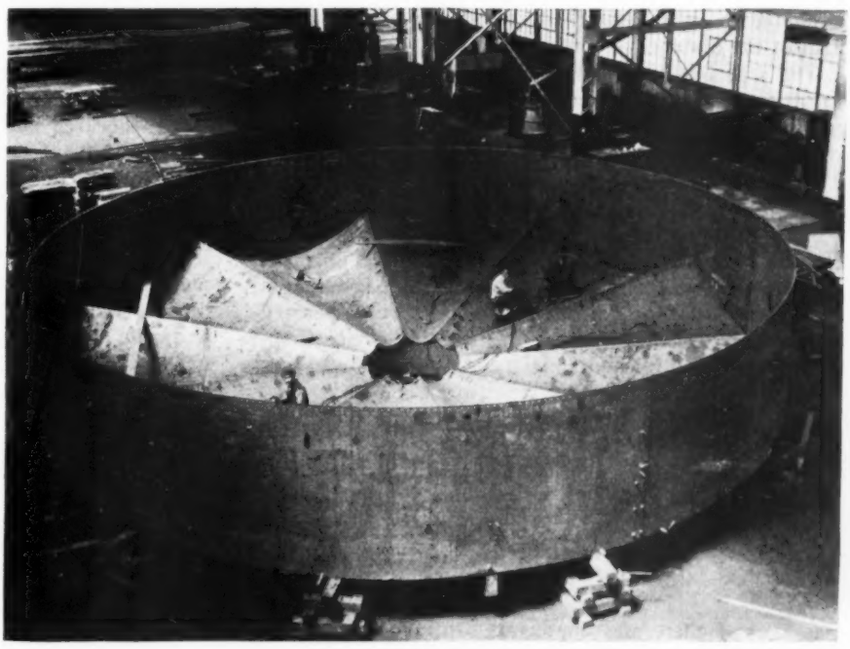


The Towson (Baltimore) tank, radial cone bottom used. Capacity 300,000 gallons, diameter 42 ft., depth 30 ft. Height from foundation to high-water line, 103 ft. This is an adaptation of the design receiving first prize in a competition in 1931 sponsored by the Chicago Bridge & Iron Works.

Welding of tanks is coming into use. Of the above, all parts of the Evanston, Towson and Tallahassee tanks were welded except the shell, which was riveted. The 6,000,000 gal. all-welded tank at Milwaukee is believed to be the most extensive weld job on tank work yet undertaken.

Reinforced concrete tanks, because so many of them leak, have in recent years been limited to 20 to 30 ft. depth. The difficulties are that the tensile stresses in the concrete accompanying any reasonable working stresses in the hoop steel exceed the ultimate strength of the concrete, without the added effect of shrinkage stress; and the difference in temperature between the inner and outer faces tends to produce horizontal cracks. At Savannah, Ga., a dual tank — two tanks, each about 30 ft. deep, set one above the other—having a total height of 196 ft. 8 in. was constructed in 1911, but is still in satisfactory service.

A number of tanks have been built on the Hewitt System, which builds a concrete shell without reinforcement, then surrounds it with horizontal steel hoops equipped with turnbuckles by which they are stressed up to about 80% of the permissible stress—such that when the tank is filled the stress in the concrete will reach zero at the same time that the stress in the hoop steel reaches its safe value.



RADIAL CONE BOTTOMS—*This type of bottom consists of a series of radial conical trough sections connected to radial girders, each girder being supported by the central riser pipe and by one or more posts. The stress in a bottom plate depends upon the radius of the cone of which the bottom plate is a portion. This radius may be increased or decreased by changing either the number of troughs or the depth of the troughs between girders. It is this flexibility which makes it possible to build a tank of large capacity having a very shallow bottom. When the radial conical troughs are extended to an intersection with the cylindrical shell of an elevated tank, the appearance is much the same as that of a flat bottom tank on a tower. This type of construction was used on the Towson tank. This appearance has been modified in several instances by the following method: The truly conical portion of the bottom extended to a diameter several feet smaller than the diameter of the shell. From this point dished plates curved outward and upward to connect the troughs with the cylindrical tank shell. This type of construction was used at Columbus, Evanston, and Tallahassee. In appearance this bottom is similar to a very shallow ellipsoidal bottom. The Chicago Bridge & Iron Works is now constructing pressure tanks having radial cone roofs as well as bottoms, roof and bottom being connected by tension members.*

Reconditioning a Forty-two-Inch, Forty-two-Year-Old Pipe Line

Newark, N. J., begins cleaning and recoating the tuberculated interior of the steel pipe bringing its water supply from the Pequannock water shed

PERHAPS the most important work undertaken by CWA forces in the New York Metropolitan District, and one that is of interest to water works men for other reasons, was the cleaning and reconditioning of part of a 42-inch pipe line which brings water to Newark, N. J., from the Pequannock water shed. This work was begun last November, and was continued until April 26th. With the termination of CWA aid this work also stopped, both because the use of the line would be needed for supplying water in summer and also for technical reasons as will be explained later; but the city expects to renew the work next Fall.

The city of Newark derives its supply chiefly from the Pequannock water shed, from which it is brought in two parallel steel lines, 21 miles long, one 42-inch and one 48-inch, direct to the city; while a 60-inch line brings it by another route from a reservoir which is used as a settling reservoir at times when the water carries sediment. The 42-inch line referred to, which was laid about 42 years ago, is the one being reconditioned. It is proposed to complete reconditioning this, and also the 48-inch, to Great Notch, about half way to the watershed. North of there a considerable part is laid in clay swamp land and has deteriorated so badly on the outside that it seems necessary to replace it rather than attempt to recondition the old pipe.

The 42″ pipe is of steel, riveted throughout, laid with a cover of about four feet, increased to a maximum of 8 feet in some places by fills made later. It was known to have become very badly tuberculated inside, and the discharge had fallen from 62 mgd. to 44 mgd., a loss of nearly 30 per cent. The work done consisted of removing the incrustation, together with a deposit on the bottom about an inch deep, and painting the entire inner surface with Bitumastic. The work began at Belleville and was carried north for 4,060 feet, or about one-fifth of the distance to Great Notch.

The pipe had been laid with manholes about 800 to 1,000 feet apart. In addition, there were "pass-holes" (through which the hot rivets were passed during construction) in the top of the pipe at 60-foot intervals. These were uncovered and opened, but no other part of the pipe was uncovered.

During the operation in a section, it was lighted by electric lights 12 to 15 feet apart, supported on poles in the pipe, and was ventilated by suction fans located at manholes. Both the lights and the fans were operated by current from the wires of the Public Service Company, which established four transformer connections, from which it furnished current through meters. The lamps were protected by wire guards. In addition, each painter, when applying the bitumastic, was provided with a hand light which he held in one hand while painting with the other.

In ventilating a section, a bulkhead was placed just beyond each of the two manholes which limited the section, and a fan was located above one of these manholes. As it was necessary to use the manholes for the passage of men and materials while work was in progress, the fan could not be set directly in or on it, but an "air lock" was used—a small, square frame shed set over the manhole and made air-tight, in the roof of which was set a fan with vertical shaft carrying its motor on top and enclosed in a weather casing. The door of this "air lock" was opened as seldom and briefly as possible, a door man being in charge of this.

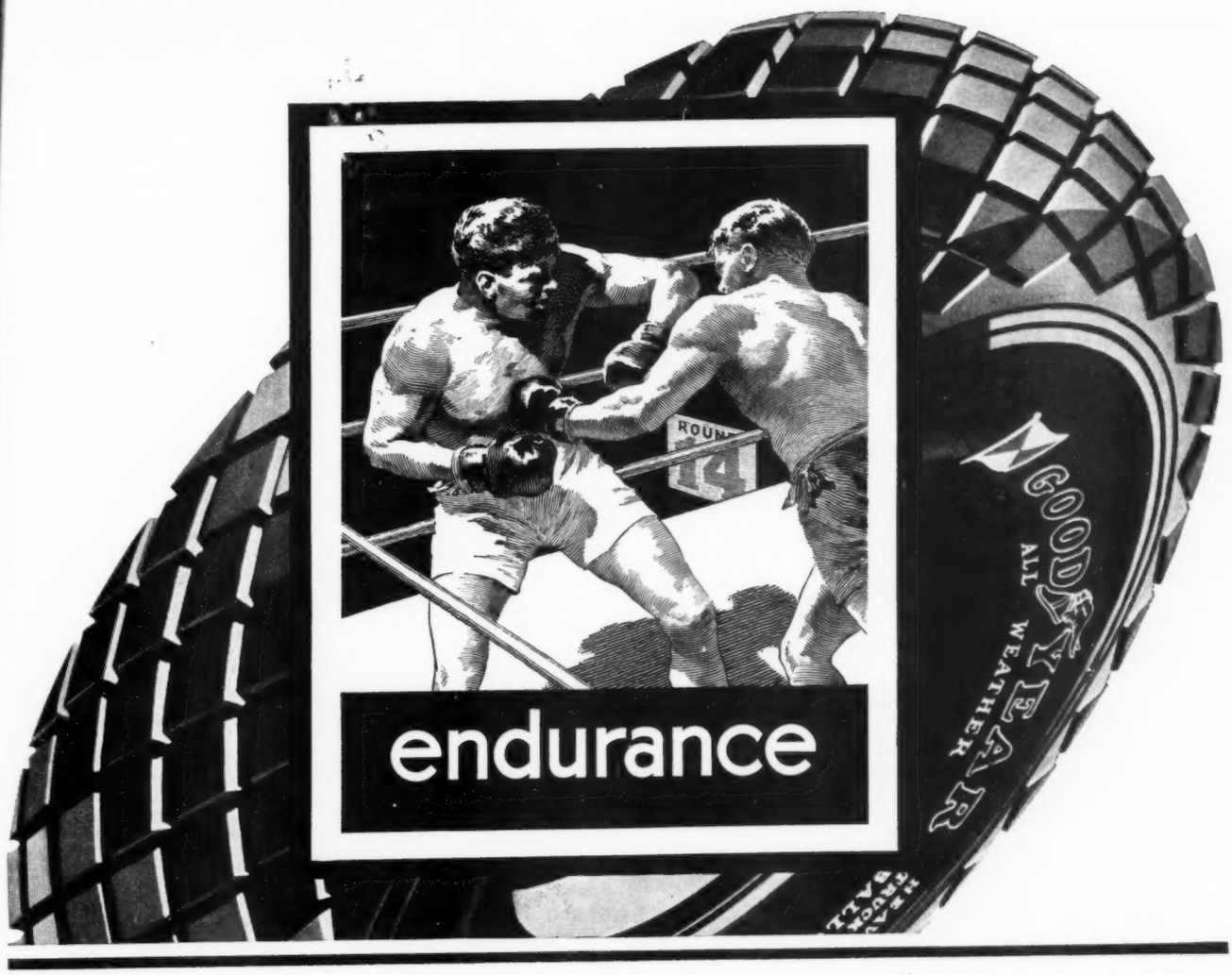
The fan was an L. J. Wing, 22H18, 3500 cu. ft. capacity, operated by a ¾ hp. 1750 rpm. single-phase motor. This gave a velocity of air through the pipe of 3 feet per second. Ventilation was necessary not only because the air in the pipe was being used by a great number of men (50 to 75 working at a time scraping and cleaning the pipe), but because of the dust caused by the scraping and brushing, and of the fumes from the paint. All men scraping wore goggles and dust-proof respirators, while the painters wore goggles and chemical respirators.

The most serious difficulty encountered was that caused by the depositing of moisture on the interior of the pipe when the outside air was warmer than the pipe metal. In cold weather there was no trouble, but at times on warm days in March and April the pipe surface could not be kept dry for painting. Artificial cooling of the entering air would have been very expensive, and discontinuing ventilation during painting could not be considered. This was one of the three reasons for stopping the work at the end of April.

For removing the tubercles the men used two-handed scrapers, made by a blacksmith from old wood rasps which the water department had on hand, which were flattened at the end to an edge about 2 inches wide. These were sharpened at intervals by the blacksmith. The material scraped off, together with the bottom deposit, was placed in burlap bags and removed at the nearest manhole. Following this, the surface was brushed with a Black & Decker grinder with a ¼ h.p. motor, which operated an Osborn wire cup brush, a ball of steel shavings being placed in the cup to increase the area polished. Finally, just before the surface was painted it was wiped off with rags (purchased in bales and cheaper and better than waste).

Practically the entire surface was covered with tubercles of a thickness up to ½ inch, except that, for a stretch of about 1,000 feet, the lower east quarter of the pipe circumference was covered with about half an inch thickness of the pipe coating which apparently had run down from above. When and why this happened and why on the east side only is a problem that no one seems to have an answer to.

In recoating the pipe, it was first painted with a primer put on cold with wall brushes. When this was dry, the Bitumastic enamel, heated in a tar kettle to 425°, was applied, using a dauber of Tampico fiber. The dauber was dipped in the paint bucket, given a 9-inch stroke forward and back and again dipped and applied, each stroke overlapping the previous one, and care being taken, using the hand light, to see that all the surface was covered to a thickness of ⅛ inch. The



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primer, Bitumastic and heating kettles were furnished by the Wailes-Dove-Hermiston Co., which furnished an instructor to train the men in applying the coating.

To insure applying the material while sufficiently hot, the buckets had to be refilled frequently. Instead of going to a manhole each time, a painter would go to the nearest "pass-hole," through which hung a string connected to a semaphore erected above the ground surface. Pulling this notified the kettle man that the painter below needed more paint, and it was poured through a funnel inserted in the hole, falling into the bucket beneath.

During the painting of the upper part of the pipe, a plate of sheet metal was spread on the bottom immediately below to catch the drippings, which were afterward recovered by melting. Painters wore gloves with long gauntlets to protect hands and forearms, and there were few cases of burns—no serious ones. In fact, there were no serious accidents of any kind during the work, although most of the men were unaccustomed to any such work.

The bitumastic is inflammable and smoking on the job was prohibited and fire extinguishers were kept at hand during painting, but no fire occurred.

When painting a section between manholes had been completed, the entire surface was inspected by a city representative wearing rubber overshoes, and the section was then shut up by bulkheads to prevent injury to the surface or entrance of dirt or polluting substances. When the work ended, water was admitted to the 8,000 feet of pipe which had been emptied, filling which required about 12 hours, during which time liquid chlorine was applied by a W. & T. chlorinator at the rate of about 4 lb. an hour—a total of 50 lb. This chlorinated water stood in the pipe for 24 hours, was drained out, and the pipe washed out with fresh water. Numerous blow-offs at low points along the line were utilized for this as well as for the original draining of the line.

All of the labor, including foremen and general supervision, was furnished by the CWA, which also furnished the paint and other material. The city furnished all equipment—boots, gloves, goggles, brushes, tools, etc., also one inspector and an engineer in charge. Approximately 150 men were at work most of the time. Many of them were skilled and gave good service, including 7 or more electricians who looked after the lights, fans, etc. Common labor received 50 cts. an hour, painters 80 cts., foremen $1.20, electricians $1.50.

The total cost to the CWA was about $30,000 for labor and materials, while the city paid about $10,000 for equipment, part of which can be used for the continuation of the work. This gives a cost of $10 a lineal foot, but if done by regular skilled labor, using equipment now on hand, the cost would be much less.

The city officials connected with the work are Meyer C. Ellenstein, director, and J. W. Costello, chief engineer, Dept. of Public Affairs; William G. Bank, division engineer, Division of Water; A. B. Anderson, assistant engineer in charge of the work; J. E. Garrett, designing engineer of the division.

Sludge Pump Clogging Reduced

Non-clogging sludge pumps in Norristown, Pa., gave considerable trouble by clogging with screenings. The wetted level of the bar screen was raised, as a result of which the screenings caught here increased from 10.2 cu. ft. per week to 8.2 cu. ft. per day, and pump trouble ceased.

The Water Wheel

Following are the essential features of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form and condensed and interpreted.

IN ammonia-chlorine treatment "the addition of ammonia to raw waters ahead of chlorination has been in several instances an effective taste prevention procedure, but care in manipulation is required, and the practicability of the process in comparison with post-ammoniation is to be questioned.[B6-2] . . . Modern practice involves the use of lower and lower ratios of ammonia to chlorine." Instead of 1 ammonia to 2 parts chlorine, as at first, present practice of postammoniation (ammonia added after filtration but prior to final chlorination) is 1 to 4 or even more parts of chlorine. "The required ammonia-chlorine ratio is a fixed quantity for any fixed condition, but the ratio varies decidedly with the pH value of the water." If there is already some ammonia present in the water, it becomes necessary only to make up the deficiency.

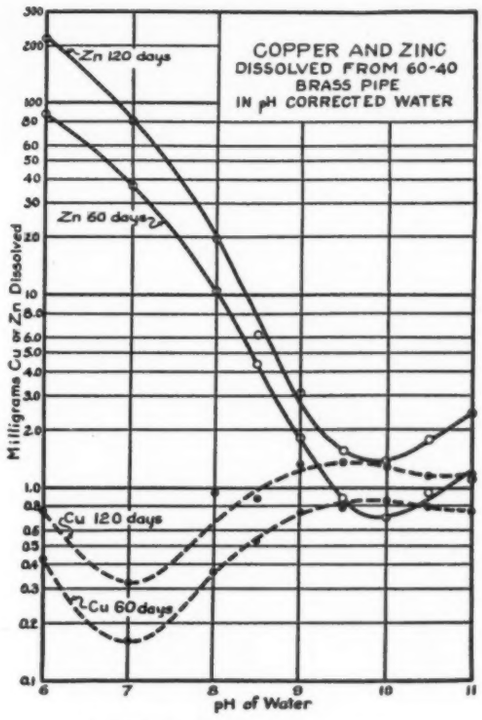
"It can now be stated with fair assurance that about double the residual to produce former efficiencies with ordinary chlorination (after 10 minutes of contact) will be required when changing over to the ammonia-chlorine treatment. That 20 minutes of contact and preferably a longer period should be anticipated as the minimum safe requirement." In Chicago it took 1½ hours contact to get effective disinfection with ammonia-chlorine, and to secure this, the treatment is applied at the intake crib, far out in the lake.

The **orthotolidine test** on ammonia-chlorine treatel water should be made within 5, or at least not more than 15, minutes after adding the orthotolidine.[B6-2] "The maximum color that one gets after adding the orthotolidine, whether it is two minutes or five minutes or ten minutes, is the most nearly correct reading to take." There may be two peaks in the color, one indicating chlorine, the second (which might be higher) indicating something else—usually manganic or ferric compounds in an organic water or sewage.

Although attempts have been made to find an indicator more satisfactory than orthotolidine, they have been unsuccessful.

Ozone as a sterlizing agent was "found entirely satisfactory by the Metropolitan Water Board, England,[M8-10] in an experimental test and it is planned to do further work on a plant scale. Paris sterilizes 60,000,000 gpd with ozone and "in 1930 there were 54 installations in satisfactory operation throughout that country."

Corrosion of brass and other non-ferrous metals by increasing the pH of water to reduce the corrosion of the ferrous ones was studied by E. W. Moore[B6-6] and he concludes that: "(1) Dezincification of brass appears to decline from pH 6.0 to a minimum at pH 10.0, and then to rise slightly to pH 11.0. (2) Solution of copper from brass appears to depend on the amount of zinc dissolved, minimum zinc dissolved coinciding with maximum copper dissolved. (But the amount of copper dissolved is small in any case). (3) Protective films retard dezincification only in a limited range—about pH 7.5 to 9.5."



Corrosion of brass pipe in water

F. G. Smith (American Brass Co.) said their experience was that a pH value of 9.0 to 10.0 in domestic water does not always give protection to 60-40 brass pipe; that the mineral constituents of the water have as much bearing on corrosion as pH value. "Where the water is neither acid with carbon dioxide nor alkaline with normal carbonates, that water is not corrosive and the pH will be somewhere near seven but not nine or ten. . . . Red brass containing 85 percent copper, or pure copper, are not much affected by waters which are either acid with carbon dioxide or alkaline with normal carbonates. . . . We have learned from experience that yellow brass pipe is not suitable for water services as it may fail underground principally on account of stresses due to settling of the soil. For the past nine years we have been recommending and selling red brass pipe containing 85 percent copper.

Gordon M. Fair said that while both sodium carbonate and lime will raise the pH value of water, the former will not form deposit coatings, while lime may do so, and these deposits may be the protective agencies rather than the higher pH values. He is therefore more favorable to the use of lime than of soda ash. E. S. Chase stated that tests showed that if the pH is raised with soda ash above 9.0, the iron was corroded almost as fast as at the lower pH values.

In at least two instances cited, grounding an electric radio on a brass water pipe caused such rapid disintegration as to turn the water blue.

Capacity of a water tank is designed at one-third the average daily pumping by E. M. Proctor[M5-3]; but no small town or village should build a tank of less than 60,000 gal. capacity. This gives a 6 or 8-hour supply to tide over a stoppage of the pumps, and "The records in connection with the hydro-electric power supply in Ontario would seem to indicate that there are very few breaks in the power service that exceed this time . . . but

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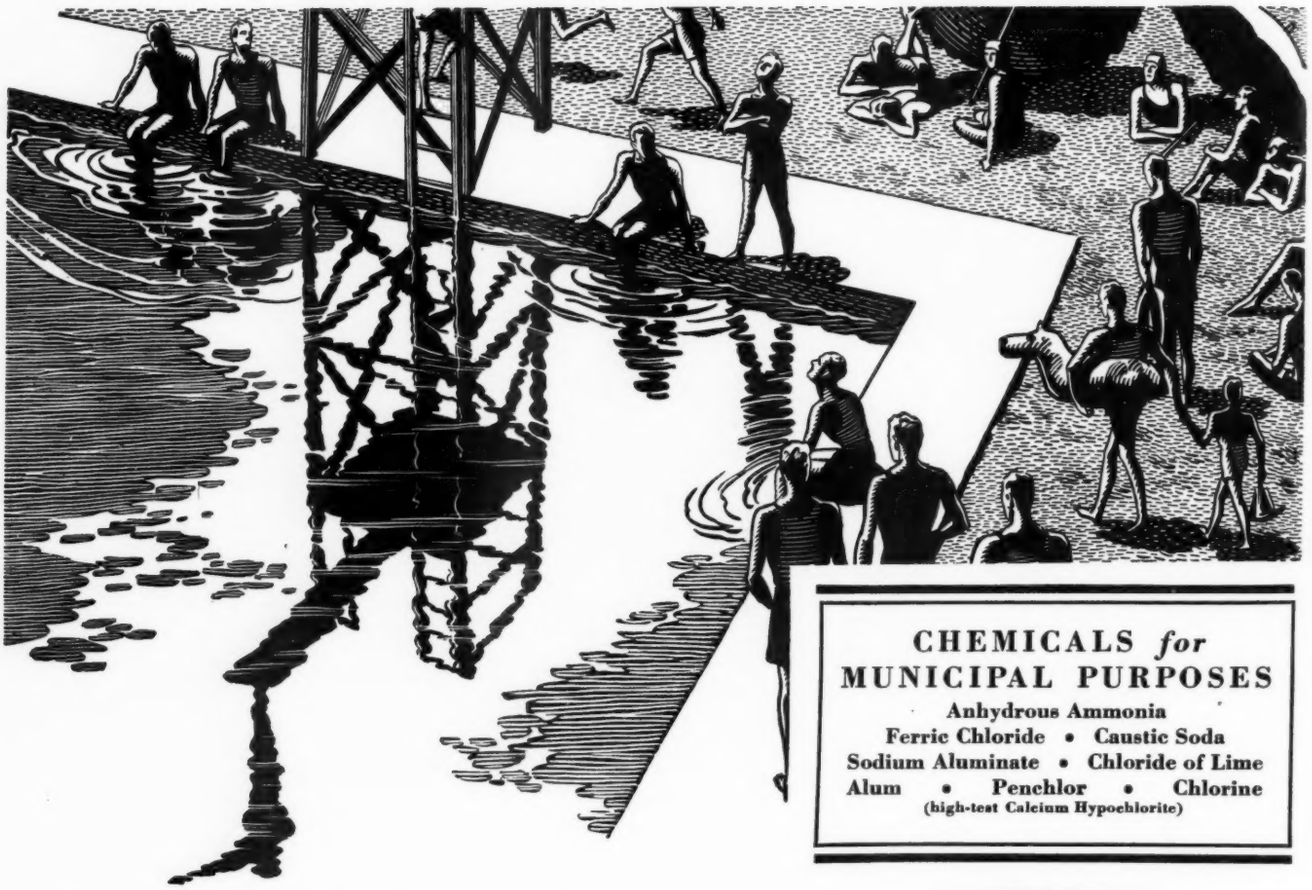

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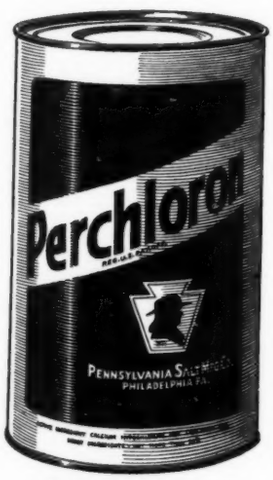

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in order to take care of fire conditions an auxiliary pumping equipment is always necessary. This size of tank will also allow most of the pumping to be done in off-peak power periods."

Size of meter needed for a given service can best be determined for the larger installations by use of a graphic recording register (which at least one manufacturer can supply).[M5-7] "This device, by the way, will also be found most useful for investigating complaints of high bills."

Metering low rates of flow is more important than is generally realized.[M5-7] Continuous dribbles at defective ball cocks, valves and faucets and use by small ice machines, air conditioners and aquariums total relatively large quantities and should be measured and paid for. In London, Ont., all meters must show 75% accuracy on a flow as low as 2 imperial gallons an hour. The late Allen Hazen said that "testing meters, especially domestic meters, at low rates of flow goes to the heart of the under-registration problem. . . . Testing meters at low rates of flow has been neglected."

Thawing hydrants in Taunton, Mass., when frozen solid, is effected with the use of carbide, a lump that will pass the nozzle of the hydrant being placed in it. This will bore a hole through the ice in a few minutes so that a small stream of water can pass through the hydrant, which will then melt and wash out the rest of the ice. This, said superintendent King, "is much handier than trying to get hot water or steam into the hydrant."[B6-8]

During cold weather each hydrant is tested at intervals for dryness, and denatured alcohol placed in those that cannot be kept dry.

Marking fire hydrants is used in Elmira, Ont., to indicate size of main and connection which feed the hydrant to assist firemen in selecting those of the available ones which will give the best flow.[M5-4] Three-inch aluminum figures are placed below the nozzles on the barrel, which is painted red. A 4" branch leading from a 6" main is designated by the number 46; a 6" branch from an 8" main by 68, etc. No 4" branches have been used in recent construction.

Underground leaks which do not flow to the surface are located in Toronto, Ont.,[M5-6] by walking over the routes of the mains "in the early mornings of Summer and Autumn when there is a damp atmosphere. On such mornings for an hour or two there will be a damp spot on the pavement or sidewalk immediately over the point where a leak exists. Up to the present, an investigation at such points has always resulted in the location of a leak immediately below."

An elevated tank collapsed completely during an earthquake at South Gate, Calif., in March, 1933.[E5-2] The principal causes were faulty wing plates on the tower columns to which the bracing rods were attached; and in other respects standard specifications of the Board of Fire Underwriters were not followed.

Earthen reservoir embankments too commonly have insufficient freeboard[D5-2] sometimes due to settlement not allowed for. Waste weirs must rest on unsettleable material, and their channels be adjusted in size to the velocity of the overflow, which increases at the top of the channel and decreases as it flattens out at the foot.

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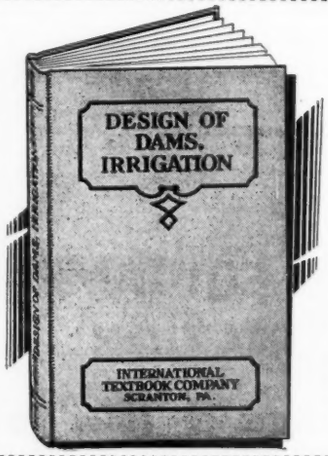

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Appearance of water works building was carefully considered by Wilmette, Ill., in works recently constructed.[A5-7] One building will house low-lift and high-lift pumping plants, filter plant and a bath house; and as it is located in the center of the public bathing beach, "every effort has been made to avoid detracting from the surrounding developments. The roof of the works will be maintained about even with the top of the bluff into which the plant is partly built" which will leave an unobstructed view of beach and lake from the country club just west of it. The roof of this building will form a promenade deck with an area of about 100 by 275 ft. which will be tiled and contain an ornamental fountain. The top of the filtered water basin, outside this building, will be used for a tennis court, a gravel fill being placed on the roof of the basin and a thin concrete slab on top of this.

Water for tenants must be provided by landlords in Ontario Province,[A5-5] an act of the Legislature requiring the owner of every house in a municipality to provide for the occupants a sufficient supply of wholesome drinking water. If any occupant claims his landlord is not doing so, he may complain to the local Board of Health, but must pay the expense of the investigation if the complaint is found unwarranted.

Municipality liability for disease due to water it supplies has been affirmed in Ontario[A5-5] where a court decision contains the words: "A municipality which knowingly maintains a dangerous water supply is answerable for damages to all persons who suffer ill health or contract disease by drinking water from such source."

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c, Indicates construction article; *n*, note or short article; *t*, technical article.

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3. The Design and Care of Rapid Sand Filters. By A. B. Morrill and W. M. Wallace, pp. 445-460.
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5. How Many Accounts Are Necessary for the Practical Application of Mechanical Billing Equipment. By E. A. Kalkurst, pp. 477-487.
6. Lime Sludge and Its Disposal. By Harry T. Campion, pp. 488-494.
7. The Howard Bend Plant of the St. Louis Water Works. By C. M. Daily, pp. 495-500.
8. The Hull Waterworks System. By Theodore Lanctot, pp. 501-504.
9. The Ottawa Water Works System. By A. D. Stalker, pp. 505-515.
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11. *t.* Adsorption of Copper-Sulfate by Aluminum Floc. By C. J. Brockman, pp. 524-526.
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3. *c.* Best Methods of Cutting Lined Pipe. Discussion, pp. 23-25.
4. The Days of Small Things. By Charles W. Sherman, pp. 26-27.
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6. Corrosion of Brass in Water Subjected to pH Correction. By Edward W. Moore, pp. 47-58.
7. A History of Water Service Installation in Newton. By Michael J. Herlihy, pp. 59-65.
8. Water Works Practice at Taunton, Mass. By Arthur C. King, pp. 66-71.
9. Results of Water Waste Survey in Lexington, Mass. By A. A. Ross, pp. 72-75.
10. Changes in Practice and Recent Improvements in Water Supply at Newton, Mass. By Richard H. Ellis, pp. 76-87.
11. Engineering Problems Connected with Recent Improvements to the Newton, Mass., Water Supply. By Geo. A. Sampson, pp. 88-101.

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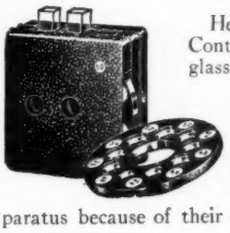

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Reduction in Cost and in Leakage Obtained by Using Joint Compounds for Water Mains

J. HANNAN, JR., of Pleasantville, N. Y., during the last few years has used two joint compounds for cast-iron pipe joints—Leadite and Hydrotite—on pipe of 6″ to 18″ diameter. His experience with the use of these in practically all types of distributing systems has been "very satisfactory," and he believes that "considerable savings can be effected, both in the cost of installation and in the amount of leakage to be expected, by their use."

Discussing the subject in a paper before the New York Section of the American Water Works Association, he lists the claimed advantages as: Economy in construction; ability to withstand vibrations and temperature changes; durability, strength and tightness; and reduction of dangers due to blow-outs during pouring. The disadvantages advanced are: Uncertainty of a satisfactory job if used by unskilled mechanics; time required to carry out leakage tests; difficulty of repairing and salvaging joints, and prejudice of men skilled in the use of lead.

Of economy there seems to be little or no question. Information he has gathered from water contractors indicated a saving of approximately 10%.

In connection with action under vibration, he had an opportunity to compare two lines, one jointed with lead and the other with a compound, laid on opposite sides of the same street where the soil was soft and swampy. The lead-jointed pipe was laid first, and two years later, when the compound-jointed pipe was laid, was uncovered and found to be leaking badly and the joints were all recaulked. About three years later both lines were tested, and the lead-jointed line was leaking worse than before recaulking, while the compound-jointed line leaked less than when accepted under a requirement of 1 gal. per foot of joint per 24 hrs. In another case a hydrant was knocked 30° from the vertical by a truck, and jacked back into vertical position, revolving about a compound joint between the base of the hydrant and its 6″ connection; and at no time then or for two years afterward did this joint leak.

Durability can be determined only by long use. There seems to be no question of durability up to the present time.

Strength also appears to be unquestioned. The author cites a personal experience where, by mistake in testing a line, pressure was run up to 400 lb.; and a gate valve on a hydrant branch, to which no hydrant was yet connected and which was not braced, was not forced off by the 5.6 tons pressure (although there was presumably no bead on the end of the short branch) and showed only slight sweating.

Leakage of composition joints seems excessive when they are first tested—from 7 to 50 gal. per foot of joint; "one fact however is certain, and that is that the joints do take up after the line has been filled with water. After the joints have taken up, there is no question but that very satisfactory leakage tests can be obtained." Tests made under Mr. Hannan's supervision seemed to demonstrate that "requirements in specifications for new work could be reduced to at least three-quarters of a gallon (of leakage) per foot of joint per 24 hours."

Of the disadvantages, that of the length of time—10 to 30 days—that a line must stand full of water before being tested is a serious one if the line must be left uncovered until tested. But the author requires only that the line be subjected to pressure and the joints examined before it is covered. An inspector of experience can tell if the leakage at any joint is excessive, and if he finds them "reasonably tight" it has almost invariably been found that the leakage tests would be satisfactory within a period of from ten to thirty days after the water has been placed in the mains.

The difficulty of finding or training men skilled in the proper use of joint compounds is not at all serious, in Mr. Hannan's opinion, since "the amount of training necessary to produce a man of sufficient skill to insure that he can properly pour compound joints is so much less than that necessary to insure that a man can satisfactorily caulk lead joints."

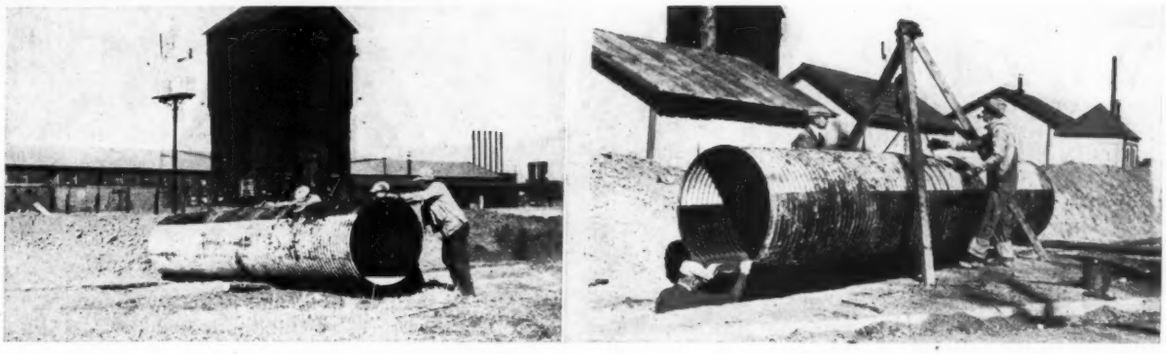
The difficulty of repairing faulty joints is a real one. In the author's opinion it simply can not be done. "Compound manufacturers claim that a portion of the joint may be removed and re-poured and a satisfactory job will result. This generally has not been the writer's experience, except in cases where very low pressures have been used. . . . The joint would appear to be tight from the first inspection, but does not appear to be capable of withstanding the shocks to which a water system is ordinarily subjected."

Mr. Hannan used a joint compound on a suction line under a lift of approximately 9 ft. but so much air entered that he found it necessary to remove the joints and recaulk with lead. Keeping the line filled with water without suction for a time did not cause it to tighten.

Conditioning Sludge for Vacuum Filtration

Hagerstown, Md., put into operation last May a new sewage treatment plant in which sludge from activated sludge tanks mixed with primary sludge is dewatered on two Wright vacuum filters 8½ ft. diameter and 10 ft. long. Referring to this plant in his report for 1933, Abel Wolman, chief engineer of the Bureau of Sanitary Engeering, State Dept. of Health, says: "The designed treatment provided conditioning of mixed primary and activated sludge with lime and paper pulp. Conditioning and filtration were on the batch system. Expected yields were 1 pound of net sewage solids per square foot of filter area per hour. For the past eight months the yield averaged about 0.7 pound. Recent changes to increase the yield provide for replacement of batch operation by the continuous method and conditioning with ferric chloride and lime. Recent yields under the new system without paper have averaged 1.9 pounds of dry sewage solids per square foot per hour. Filter operating hours have dropped from an average of 20 to 7 per day.

"Inauguration of the use of ferric chloride and lime as conditioning agents has been too recent to indicate at this time the minimum requirements of these chemicals or the possibilities of further increases in yields of dry solids."



Three men rolling an 18-foot section of 42-inch Armco pipe into position for lowering into the trench, as shown at right.

Storm Sewer Installation by Relief Work

By Knowlton L. Brode, *City Manager, Newton, Kans.*

FOR years the City of Newton has felt the need of additional sewer lines to handle storm and sanitary sewerage. However, reduced revenue made it impossible to undertake the work until the Civil Works Administration made government money available for municipal construction work.

One of the locations most in need of more adequate drainage facilities was an important industrial section of the city where a large part of the drainage was carried in open gutters, and a heavy rain meant flooded basements and the damage, inconvenience, and unsanitary conditions that accompany this type of a situation.

Plans having been prepared for an adequate drainage system, the next problem was the selection of the pipe. After a careful consideration of the various types, the city officials selected Armco iron pipe, with paved invert. The order was placed through the Road Supply and Metal Company, of Topeka, Kansas. Among the reasons for choosing Armco pipe were previous very satisfactory experience with this pipe over a period of years, its economy and its durability. The paved invert type was selected because of the protection this afforded the bottom of the pipe, where the wear is heaviest.

Also, cost of installation was reduced by the fact that this pipe is light in weight and can be handled without the use of special machinery. It is the opinion of the writer that these cost-saving features should be taken into consideration, especially on unemployment relief projects, since it makes money available for additional jobs that give work to more men.

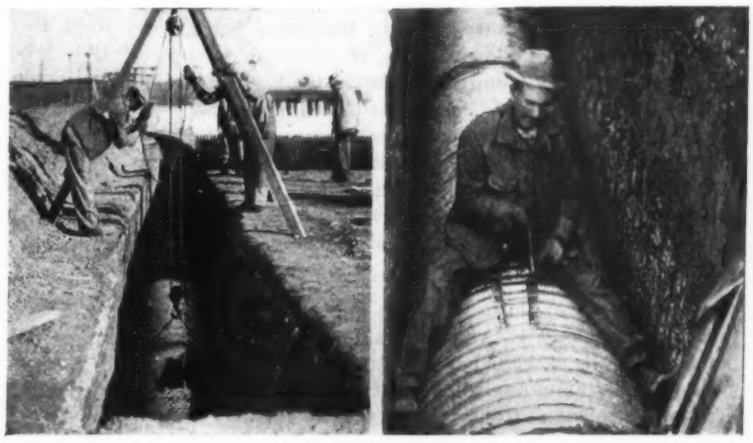
Another important factor in our choice of materials was the fact that the work was to be done during the winter months, and it was necessary to select a type of construction that would permit the work to be carried to completion in spite of weather conditions.

The total length of the projected line was 1326 feet. The pipe was furnished in 14-foot, 18-foot, and 20-foot sections. The use of these long sections which could be easily jointed reduced the time and cost of installation, and ensured a finished sewer line that would tend to hold alignment, even with unequal settlement or very heavy traffic.

In order to give work to as many men as possible, hand labor was used throughout. The cost of excavation and backfilling, including supervision and timekeeping, amounted to $2.10 per foot of pipe laid. Unloading, laying and connecting 1326 feet of 42-inch diameter pipe in a trench with an average depth of 6½ feet amounted to only 93 cents per foot of pipe.

Because of the relatively long lengths in which the pipe was furnished, the line was laid in a remarkably short time. Heavy connecting bands were used at the joints and tight connections made with the use of only a small hand wrench. Backfilling was done as the pipe was installed, and the entire job was ready for service as soon as the last section had been put into place.

The labor used was largely unskilled, and costs might have been reduced had skilled labor been used. However, there was an unemployment problem to be met, and the city thought it best to give work to as many men as possible.



LEFT, *the pipe is lowered into the trench where the lengths are easily joined together, as shown at the right, using unskilled labor.*

What Is Rolling?

By Bernard E. Gray
Highway Engineer, Asphalt Institute

"THE surface then shall be rolled with a three wheel power roller weighing not less than ten (10) tons, until it is compacted to a firm, even surface." How many specifications contain this wording, and how many arguments have taken place between contractor and engineer as to when the surface was really firm and even? What does a roller do, and does it make any difference whether the roller wheel varies in width, is crowned or flat, just so long as there are three wheels and the total weight is correct? Are there some surfaces that do not require rolling at all, where a distinct saving could be had through the elimination of such a requirement? Such questions have been asked for years, and it is believed worth while to present at this time the conclusions gained in a long active connection with highway construction supplemented by a survey of present day specification standards.

Pavement Design

One of the principal reasons why so many old bituminous pavements were wavy and uneven was the fact that they were *built* that way. The old idea that regardless of the smoothness of the subgrade and the base, the surface could be made smooth by a light rolling, was a fallacy that unfortunately still persists in some quarters. Specifications often had no requirement for smoothness except on the surface, and this often was as much as ¾ inch permissible variation in ten feet. The likelihood of obtaining a smooth riding surface under such control is rather remote.

It cannot be too strongly emphasized that the character of the finished surface depends upon the care with which each operation is concluded, and probably most important is the item of consolidation and compaction, so that subsequent traffic stresses will not produce noticeable distortion. The fundamental principle of pavement design is that these traffic stresses are transmitted to the subgrade without breaking the pavement and over such an area of the subgrade as will provide support well within its strength. To obtain the highest possible subgrade values it is essential that a uniform condition be produced therein, and this means uniform character of material, and consolidation and compaction in a uniform manner. Rolling, sometimes in conjunction with some means of uniform spreading, is the best method for accomplishing such purpose.

Function of the Roller

The function of the roller is to apply such pressure to the surface as will produce a state of consolidation not likely to be exceeded by the traffic load. Inasmuch as the wheels of motor vehicles are less in width than a roller wheel, it further follows that it is the weight per inch of width of roll that is important, rather than merely the total weight of the roller. To specify then only the type and total weight of a roller is to tell but part of the story, and the new specifications recognizing this fact, are now adding (except in certain instances) the clause; "——and with a minimum weight (or pressure) of (——) pounds per inch width of rear roller wheels." The number of pounds will vary according to the type of surface.

Again, while there is no substitute for judgment and experience in determining when a surface is really "firm and even," a great deal of needless argument and misunderstanding can be prevented by making still further provisions in the specification for the amount of rolling to be done on a particular class of work. It is true that the modern motorized roller is much more efficient than the old steam roller, and will do substantially more effective rolling per hour. However, this is a measurable quantity, and for the various types of surface, taking into account character of aggregates, climatic conditions, topography, etc., ample experience has been gained so as to fix minimum requirements for any particular job. The question of both how much rolling and how many rollers then can be answered by some such provision as this: "The total rolling to which the (——) course shall be subjected shall average not less than one (1) roller in continuous operation for one (1) hour on each (——) square yards, with the roller operating at a speed not to exceed 3 miles per hour." If a certain amount of work is to be completed within a certain number of days, it is then a simple matter for the contractor to figure how many rollers he will need to accomplish the work in the desired manner, while on the other hand the inspector has a definite guide as to the minimum rolling required before he can expect the surface to be "——smooth and even."

All too many miles of road have required unnecessary maintenance and repairs, because they were built with but one roller when they really required two or three to have accomplished the job properly in a given time. The idea that one roller can prepare subgrade and roll a six-inch depth of stone at the rate of five hundred feet per day is a costly one. The correction of such a possible situation is to rewrite specifications in a clear manner, so that the contractor knows exactly what he must have in the way of equipment prior to bidding, and that the inspector shall have a definite method whereby to measure performance as the work progresses.

Different Classes of Work

There is no class of bituminous surface where the use of a roller will not produce superior results. The amount of rolling and the type of roller may vary, but at some stage or at many stages the rolling operation will contribute to the quality of finished work desired. There are noted herewith some of the more universally employed surface types and the character of rolling which they should receive.

(a) *Surface Treatment*—This is an all inclusive term which may mean either an original treatment of multiple applications or a single light retreatment over an old pavement. In any event, rolling is very desirable,

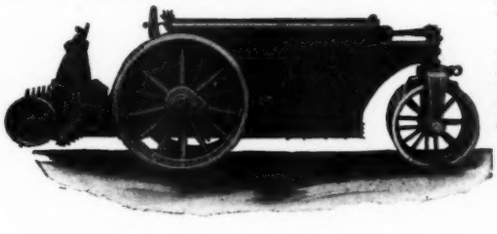
as it permits the use of quicker setting bituminous material with consequent reduced inconvenience to passing traffic, and also insures the bonding of practically all the cover aggregate, thus providing for uniform appearance and economy. Where rolling is omitted it is necessary to use slower setting bituminous products so that as the aggregate moves around under traffic until it can rebond in a new position, and in this delayed setting there is inevitably a loss of material as it is picked by tires, and of cover aggregate as it is whipped off the surface entirely. The use of a sufficient number of rollers, so that at no time is a roller more than a few hundred feet behind the application of mineral aggregate cover, will soon pay for itself. It is the first setting or imbedding of the aggregate in the bituminous material before it starts to set that does the trick, and the roller should pass once over the surface, right behind the application operations. Afterward light further rolling together with broom-dragging, will add the finishing touches. A heavy roller is not necessary for such work, and the provision of "——not less than five tons and not over ten tons" is sufficient in this case.

(b) *Road-Mix (Macadam Aggregate Type)*—Any macadam type of surface depends for its stability upon the thorough keying of the aggregate particles, and to such degree as will resist further movement under traffic. The roller provision should be for the ten-ton three-wheel type, with minimum weight of three hundred (300) pounds per inch width of rear roller wheel. There is required at least one roller per hour per 150 square yards of finished surface. The tolerance for smoothness should be not over three-eighths (3/8) inch variation under a ten foot straight edge.

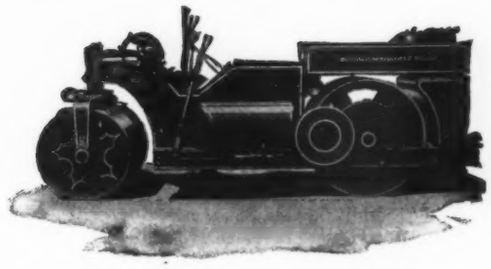
(c) *Road-Mix (Graded Aggregate Type)*—This type surface depends for stability upon the nearly complete filling of voids in the mixture, and for smoothness requires continued blading and consolidation under traffic. For a time it was thought that rolling could be dispensed with entirely, but inasmuch as traffic does not usually go to the edge of a surface in any amount, and as the edge is the vulnerable point in such surfaces, it was soon found that a light rolling at the edges to insure initial compaction was highly desirable. Furthermore, at the approach of rainy weather it is possible to quickly compact the spread mixture to shed water, so that a long drying-out period is not required before the finishing operations may be resumed. A suitable provision for such compaction would read:

"The asphalt mixture shall be spread for compaction from the windrow produced by the last mixing operation. It shall be bladed from the windrow in a succession of thin layers to a uniform cross-section of correct thickness. The edges and shoulders shall then be rolled with a power driven roller weighing not less than five (5), nor more than eight (8) tons, until thoroughly compacted. If directed by the Engineer, the roller shall also be used to close the entire surface when a period of rainy weather threatens.

(d) *Penetration Macadam*—The high strength and great durability of this type surface is primarily due to the complete keying together of the coarse aggregate particles. Upon the kind and amount of rolling depends quite largely the success of the work, both before and after the application of the asphalt cement. For limestones and other hard aggregates, except trap rock, the roller provision should call for the ten-ton three-wheel type with a minimum weight of three hundred (300) pounds per inch width of rear wheel. For hard trap rock the total weight of roller may be twelve tons with a minimum weight of as much as four hundred and fifty (450) pounds per inch width of rear roll. As heavy a roller as can be used without crushing or breaking the aggregate is desirable, and the unusually durable penetration macadam surfaces in New England are obtained largely because of excellent trap rock aggregate and the fact that the surfaces are so thoroughly rolled and keyed together under heavy rollers, that subsequent movement of the particles is virtually impossible. Where aggregates are so soft that crushing and breaking occurs under the above described ten-ton roller, the type should be changed from straight penetration to modified penetration, as it will be impossible to obtain uniform results unless voids after initial keying are uniform in character.



The Three Wheel Roller



The Tandem Type Roller

The initial rolling, or dry rolling as it is usually called, is extremely important from the strength standpoint, and rolling should be continued until the surface is so thoroughly keyed that no movement whatever is discernible. The back rolling, after the seal coat operations are completed, is important from a smoothness standpoint. For the following ten days, at appropriate intervals, this back rolling should be carried on, until the pavement is set in its final position. The total rolling in the construction of this type wearing course should average not less than one roller in continuous operation for one (1) hour on each one hundred (100) square yards, with the roller operating at not more than three (3) miles per hour. The tolerance for smoothness of the finished surface should not exceed three-eighths (3/8) inch under a ten foot straight edge.

(e) *Hot-Mix Pavements*—While great improvement in smooth riding qualities has been made in this class of work through the use of mechanical spreading and finishing, proper rolling to insure ultimate density and smoothness is essential. On some work two different types of roller are employed, one the three-wheel and the other the two-wheel or tandem type. The three wheel roller should be used first for what is termed the "break-down" rolling, or the initial compression, and the rolling should follow immediately after spreading, with coarse aggregate mixtures, and as soon as no undue displacement is observed with fine aggregate mixtures. The speed of the roller should not exceed three (3) miles per hour, and alternative trips of the roller should be of different lengths so that no ridge is formed at any place. This initial rolling is always parallel to the center line of the road or street. Cross rolling is usually accomplished with a tandem roller because of greater ease in handling and because there is less tendency to cut when changing direction in lap-

ping. Cross rolling is usually at about forty-five (45) degrees with center line, with the second diagonal rolling at right angles with the lines of the first. Sometimes where right-of-way permits, cross rolling at right angles to the center line is possible. One roller per hour is required to accomplish satisfactory work on the different varieties of hot-mix pavement at the following rates:

Sheet Asphalt } Binder course not in excess of 300 sq. yds. Surface course not in excess of 150 sq. yds.

Asphaltic Concrete—not in excess of 150 sq. yds.

The minimum weight of both three wheel and tandem types should be not less than two hundred (200) pounds per inch width of rear wheel. Tolerance for smoothness of finished surface can be made not more than one-eighth (⅛) inch variation in ten feet as measured under a ten foot straight edge placed parallel to center line of road.

In this short article no attempt has been made to give all the details in connection with the correct finishing of bituminous pavements, but rather to point out some of the most important requirements and their limits. They might be summarized as follows:

1. There is no type of pavement surface but where the use of a roller is a most important factor in obtaining the best results. Even on surface treatment, rolling will soon pay for itself in the saving of material alone, to say nothing of far better results, while with higher types of surface, correct and *adequate* rolling is essential.

2. Specifications should include a section for compaction requirements which should cover not only the type and total weight of roller, but the weight per inch width of rear roll, the speed of operation, the minimum amount of rolling required per unit, and the tolerance for completed surface smoothness.

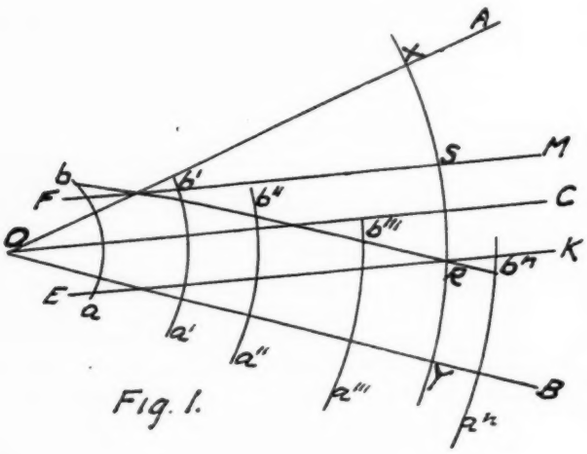


Fig. 1.

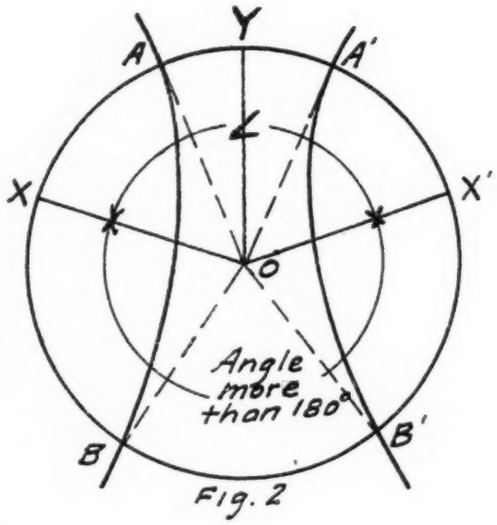


Fig. 2

Trisecting an Angle

In a letter to "Timewasters," a department of PUBLIC WORKS, which appears monthly on the Table of Contents page, Karl F. Kellerman, Associate Chief of the Bureau of Plant Industry, Department of Agriculture, Washington, D. C., sent in a problem relating to the trisection of an angle. The problem appeared on page 5 of the May issue. Several interesting letters and comments have been received.

Mr. Kellerman submits his solution to the problem as follows (letters refer to Fig. 1):

To trisect angle AOB (any angle): With O as a center, construct concentric arcs, ab, a′b′ a″b″ . . . $a^n b^n$. Using a distance convenient for construction, as *ab*, and from points of intersections of arcs ab, a′b′, a″b″ . . . $a^n b^n$, with the line OB, cut arcs ab, a′b′, a″b″ . . . $a^n b^n$. Then chords ab, a′b′, a″b″ . . . $a^n b^n$ are equal. Plot curve formed by connecting points b, b′, b″ . . . b^n.

Draw FM and EK parallel to OC (the bisector), equi-distant from OC and distance from each other by *ab*. Where EK cuts curve b, b′, b″. . . b^n will be indicated as point R. With OR as a radius, draw arc yRSx. Chords yR, RS, and Sx are equal and angles OxS, OSR and ORy are equal.

In commenting on the problem, George F. Key, office engineer, Department of Water Supply, City of Detroit, writes:

"In 1926, the writer solved the trisection problem in strict accordance with the requirements of the use of compasses and unmarked ruler or straight-edge. Several solutions, according to newspapers, have been discovered in the past few years.

"The writer has checked his work, which he calls the 'circular method,' with Aristotle's method, the roulette method of "trisectrix curve,' the 'conchoid of Nicomedes,' the 'cissoid of Diocles,' and with a 'clam shell' curve founded on a solution of problem 18, page 344, Williamson's Differential Calculus. All of the above can be evolved from or connected with the circular method of the author.

"Welcome, Brother Kellerman, to the Trisection Band."

A solution was also received from Walter S. Wheeler, civil engineer, Dover, N. H., who says:

"One of the best ways of trisecting an arbitrary angle, both more or less than two right angles, is to bisect the angle (see Fig. 2), use the bisector for the directrix, and use the points X and X′ as foci for two hyperbolas, with eccentricities of 2, cutting the circle in points A and A′ for an angle less than 2 right angles, or B and B′ if the angle is greater than 2 right angles."

The editor will be glad to have additional comment on this interesting subject.

Latest Procedures in Use of Activated Carbon for Taste and Odor Control*

By F. E. Stuart
Research Engineer, Industrial Chemical Sales Co., Water Purification Div.

ACTIVATED carbon is used for both emergency treatment to remove taste and odor from water after it has appeared, and routine control to prevent the development of them. Emergency treatment methods will be described first.

Each plant has its individual operating characteristics, but as a general average it is desirable to apply activated carbon to the filters at a dosage of 16 pounds per million gallons and a duplicate dosage to the mixing chamber.

Carbon can be applied with any dry feed machine, but a water ejector is desired to completely wet the carbon particles. Carbon cannot become too wet but it can be applied apparently wet and give poor results. Carbon which is not completely saturated will become air-locked, and inefficient adsorption will result.

As soon as the first filter with carbon particles begins to show an increase in loss of head, this filter should be removed from service and jolted. Some will not agree with this jolting procedure but it is recommended the first time a filter operates on carbon-treated water. The jolting will work the carbon particles into the filter sand the same as would be accomplished in several complete washings when filtering carbon-treated water continuously. The jolting procedure is as follows:

Close influent and effluent valves. Open wash water valve just enough to cause bubbles on the filter surface. Shut off wash water. Allow filter to stand 5 minutes and place back in service. The next run will be normal for carbon-treated water.

During this initial seeding of the filters with carbon, the dosage in the mixing chambers should have reached the filters; if the taste is disappearing, reduce the dosage being applied directly to the filter influent, but if not, continue both feeds and place all available filters in service, at the slowest practical rate of filtration. Raise or so adjust the alum dosage that the most effective type of floc is formed. Take individual samples from all filter units and determine whether any one filter is responsible for the taste or odor in the clear well.

After a few hours' operation with carbon on the filter sand there may be a noticeable increase in the chlorine residual of the filtered water. This is especially true if there is much chlorine demand present during normal operation. The reason for this suggestion is to warn against the production of a chlorinous taste which may not be noticed until considerable water has been treated. The carbon mat on the filter sand in many instances reduces the chlorine demand of the filtered water to such an extent that a much smaller dosage of post-chlorine will produce the same residual. This is an interesting feature and is important because it smooths out some fluctuations in the filtered water chlorine demand, and makes the post-chlorine dosage almost wholly available as chlorine residual. This is especially true if prechlorination is practiced.

This emergency treatment is entirely a procedure for the practical application of activated carbon, and will be found to be the quickest means of taste and odor control. Carbon can be applied in any quantity without balancing any chemical reactions or without careful adjustment of two or more chemicals. As soon as the period of emergency treatment has passed, it is advisable to look into the latest method for the production of a more palatable water. This may not meet with everyone's approval but it is worthy of thought because the consumer is becoming increasingly critical of routine conditions in a water supply and, with modern methods of control, there is no reason why good water should not be available for everyone at all times.

Routine Taste and Odor Control

Similar to emergency treatment is the procedure for preparing the plant for routine control. This consists of:

a—Seed the filters with activated carbon (jolting explained previously) in order to adsorb all organic matter present on the sand grains.

This can be done experimentally in the laboratory to prove this as a necessary step. Take two small samples of filter sand, approximately 50 cc. by volume, and place in two Erlenmeyer flasks of 500 cc. capacity—add distilled water to cover the sand approximately ½ inch. Add a small amount of activated carbon to only one flask, approximately 1 gram. Place on hot plate with small watch glass as a cover. Notice the odor given off from each. Allow to stand for two hours and shake. It will be noticed that the flask containing the carbon is odorless.

This simple test explains why some filter plants have the same threshold odor number in the filtered water as the water on top of the filters. The filters are in better shape for taste and odor removal after they have been "seeded" with activated carbon.

b—Apply carbon to the coagulation process in the mixing chamber. This is done to keep the floc which reaches the filters stable. It will not decompose in the filter sand. Also, the floc will carry sufficient carbon to keep the filter sand "seeded." Without a procedure for purposely "seeding" the filters, this small amount of carbon carried by the floc would never reach the filters in sufficient quantity to deodorize and stabilize the entire filter unit. But, once the filter is "seeded" and stabilized, the floc is carried to the filter in such a small quantity that the runs will not be shortened but in most instances will operate more efficiently, as carbon floc is not as sticky as ordinary floc.

c—Always use all available filters at the slowest practical rate of filtration, sufficient to meet all peak loads. This is one of the most important of all the procedures to be followed in routine taste control—a filter operating at a slow rate is a more efficient unit.

d—Sample individual filters to determine whether any one filter is delivering a water similar to the water on top of the filters. This should be done occasionally to give a check on the performance of each filter. During an algae period, the filters should not be allowed to run to complete loss of head, as they will sometimes pass algae near the end of the runs. This is to be determined locally.

Routine taste and odor control, using the modern methods to the best advantage, consists of:

1—Aeration (whenever practical).
2—Prechlorination.

*Excerpt from paper before Kentucky-Tennessee Section, American Water Works Ass'n.

3—Coagulation with carbon particles.

4—Filtration through filters containing carbon particles. (Brought over with floc).

5—Ammonia-chlorine treatment.

In routine taste and odor control the application of prechlorination in amounts sufficient to take care of all the chlorine demand is recommended. In previous years this has been impossible due to the chlorine residual passing through the filters at times when the organic load would drop, thereby reducing the chlorine demand and raising the residual at a point where it would produce a chlorine taste. With the carbon coagulation and the carbon-impregnated filter unit, this old handicap is removed, as the carbon particles in the filter will remove all the existing chlorine residual. The result is that the sterilization load can be carried by the prechlorine dosage.

The action of activated carbon is largely physical—the action of an alum floc is more or less purely physical once it has been formed. There are 120 billion particles in one gram of *Aqua Nuchar,* so it can be seen why a dosage of from 4 to 8 pounds per million gallons will assist in floc formation and in stabilizing sludge. The floc immediately removes impurities and settles to the bottom. The carbon in this floc appears to inhibit decay by some form of antiseptic effect.

The subject of the use of carbon in the coagulation process is sometimes referred to as just the addition of ordinary turbidity. To demonstrate that activated carbon turbidity is more than "just ordinary turbidity" another simple laboratory test should be made:

Place 50 cc. by volume, of commercial hypochlorite, H. T. H. or Perchloron on a large evaporating dish and mix an equal volume of *Aqua Nuchar* with it. Stir this mixture of carbon and hypochlorite. The result will be excessive heat and finally a spontaneous fire. Duplicate this, using equal amounts of fullers earth (an ordinary turbidity) and H. T. H. or Perchloron. You will notice no heat or fire.

This simple experiment shows the high activity of *Nuchar* activated carbon. This same activity is exerted when carbon is used in coagulation—it is the reason why it is now possible to coagulate water without having decomposition in settling basins and filter sand.

The water, having been prechlorinated and coagulated with alum and carbon particles, is ready for filtration. The floc contains activated carbon particles and will be deposited in the filter unit. This floc and carbon content is keeping the filter in a condition to dechlorinate if a large amount of chlorine residual should pass through the basin. The carbon content is beneficial in keeping down the decomposition of floc in the filter sand. The carbon-impregnated filter sand adsorbs tastes and odors of foreign origin to some extent. It is hard for a taste-producing compound to penetrate a carbon-stabilized settling basin and filter, as there is no gas of decomposition present to intensify it, and the effect of coagulation is generally sufficient to remove it. In case a taste does appear, smaller dosages of activated carbon will control it, because the plant is entirely stable and the carbon dosage will have to overcome the foreign odor only. The recommended point of application of additional carbon is directly to the filter influent; applied thoroughly wetted as explained previously.

The use of ammonia and chlorine is recommended after filtration because the chloramine residual produced is more effective in keeping down bacterial activity in dead ends than is chlorine alone—the cause of severe tastes in dead ends is probably due to the effect of occasional chlorine residual reaching the decomposing material. L. H. Enslow explains this as follows:

"Decomposition of organic deposits in the dead ends seemed to take place in warm weather. The chlorine effect having played out, the after growth of bacteria seemed to go on profusely. Then if some residual chlorine did reach the bad water in the dead ends, at times a highly medicated taste was produced. Now, however, with the use of carbon to remove tastes and most of the organic matter at the plant, and the use of ammonia and chlorine in the effluent, residual chlorine then persisting to the far ends of the system held the bacterial decomposition in check. Result: putrefaction, corrosion and resultant products of decay, including sulphide of hydrogen which produces the black water so frequently observed in main flushing, had been held in check, if not prevented. Heavy prechlorination has proven effective to destroy by oxidation much of the organic matter otherwise passing through the plant. The carbon removed excess chlorine and much of the unattacked organic matter also, including taste producing compounds."

Relief Labor in the Water Works Plant

"There are a multitude of things that can be done with little expenditure," said Charles Brossman, speaking on the subject "Water Works Construction with Relief Labor" before the Indiana section of the A. W. W. A. He enumerated some of them as follows:

"Repair the walls, roof and physical structures around the plant, repaint brick walls; mend concrete walls, roofs, etc.; waterproofing of structures; paint your pump and engine room and boiler room walls. If you have pipe, lay extensions and connect dead ends; pull and clean out wells, if necessary.

"On the light plant, make repairs the same as those above; if you have wire or cable on hand, string it where necessary, trim the trees where they interfere with wires; creosote the poles and reinforce old poles and replace guy wires.

"On the sanitation end, repair sewers and extend small sewers and laterals and make repairs to disposal plant and get them in good shape."

The Marshalltown, Ia., water department, H. V. Pedersen, superintendent, last year did considerable useful work to relieve local labor and enable them to work out their water bills. It laid several blocks of water mains, replaced a few old hydrants that had been giving trouble and repacked those that were not removed. During last fall a crew was occupied repairing hydrants and painting them with aluminum (with which Mr. Pedersen is "well pleased"). Three boys painted the 100,000 gal. tank, scraping it, giving it a coat of red priming paint followed by a coat of aluminum. "Up to now," said Mr. Pedersen, "I have not been entirely sold on aluminum paint and I still have to be convinced," but several tanks near Marshalltown had been painted with it three years before and the "jobs are apparently in such good shape that I was willing to risk it on our tank."

This department also repaired and put new foundations under the residence of its chief engineer, installed a furnace and repaired the plumbing. A gang removed stones from the bed of the Iowa river and piled them along a concrete retaining wall which the water was undermining in front of the water works property and riprapped the river bank beyond the wall; by which 125 men worked off $1,000 of unpaid water rents. They also did considerable painting on various water works buildings, filled all cracks and openings around doors and window frames in brick buildings with caulking material (that made by the Tremco Co. Mr. Pedersen found "a wonderful material for this purpose"), which keeps out the rain, eliminating danger of frost action and preserving the inside walls.

PWA Recommendations for Chicago Sewerage

RECOMMENDATIONS contained in the report of the Special Board of Engineers appointed by Public Works Administrator Harold L. Ickes to review Chicago's sewerage problem embrace

(1) Higher purification of Chicago's total sewage at an earlier date.

(2) Immediate construction of the southwest-side plant with main intercepting sewers, including those serving the stockyards.

(3) Continued utilization of the $16,000,000 west-side Imhoff plant, with supplementary chemical treatment if necessary.

(4) Curtailment of water waste costing millions annually and resulting in the requirement of unnecessarily large sewers and sewage pumping stations.

(5) Simplified design, eliminating unnecessary and elaborate, extravagant features.

Execution of the recommended program will immediately give 72 per cent treatment to the entire Sanitary District sewage, (as compared to the 56 percent provided by the former plan), which, it is believed, will accord with the Supreme Court's rulings. The Board recommended completion of intercepting sewers to a disposal plant and the construction of the necessary activated sludge tanks to care for sewerage from the stockyards district.

In the meantime studies would be carried on in the existing Imhoff tank layout for the west-side sewerage to determine if, by modern process, a satisfactory percentage of purification can be obtained. An 85 percent purification for the whole area is considered adequate.

Degree of Treatment Under Proposed Plan

District	*1940 Population*	*Percent Purification*
North Side	1,315,000	92*
Calumet	465,000	92
Southwest Side	1,245,000	92*
Packing House Equiv.	1,000,000	92*
West Side	1,790,000	33
Total	5,815,000	

*These percentages assume that by 1938 means of sludge disposal will be provided.

If this use of the west side Imhoff tanks does not prove successful economically, the District may proceed to build additional treatment works for further treatment of west side sewage. Adoption of the Board's recommendations will result in treating, in whole or in part, all the sewage in the District by 1936. If former plans were carried out, none of the south and southwest-side sewage would have been treated by then.

The Board of Engineers recommended continuance of present studies of incineration for disposal of sludge.

Inasmuch as the detailed working plans of the District's original proposal to PWA have not been completed or construction advertised or contracts let for any part of the work, adoption of the new plan is possible without delays. It would require no longer to prepare the plans of the Board's program than the rough plans proposed by the District.

A heavy burden of expense to taxpayers for both Chicago's sewers and waterworks was revealed in the Board's report, which showed that, because of this waste, far more expensive sewers and treatment facilities were required and cited other studies made of this water waste, estimating the cost of such waste to Chicago at $428,000,000 in a thirty-five year period, or $12,000,000 per year, which could be saved by water waste prevention methods, including metering. In this connection the Board reported to Administrator Ickes: "The extravagant waste of water from the Chicago water system, which has long been known to exist and which seems to be constantly increasing, has added and will continue to add millions of dollars to the cost of sewers and of the sewage disposal plant unless such waste is materially reduced. The water additionally pumped at the present time exceeds a billion gallons daily and is almost double the amount which is reasonably necessary for domestic and commercial use, as is demonstrated by the results of the use in other cities where continuous inspectioin, supervision and metering have curtailed waste with relative great economies with construction and operation expenditures."

Figures were cited to show that metering in Milwaukee resulted in a 50 percent saving; in Evansville, Indiana, in a 60 percent saving; in Cleveland, Ohio, in a 45 percent saving and in Terre Haute, Indiana, in a 68 percent saving.

Other figures were given showing that in Chicago in the Hegewisch district metering brought per capita consumption from 455 gallons down to 103 gallons a day, while in the South Park area, per capita consumption was reduced from 402 gallons daily to 194.

The Board's recommendations, in abbreviated form:

1. Alter the construction program set up by the Sanitary District of Chicago, modifying the contract if necessary.
2. In lieu of a West Side supplementary plant, build a 400 mgd. activated sludge plant designed to treat Southwest sewage.
3. Build a pumping station to serve the Southwest side, and build the main sewers of the Southwest intercepting system leading thereto.
4. Design the Southwest pumping station and the Southwest interceptors on the basis of a metered water supply in the Southwest area.
5. Determine and adopt the best method of sludge disposal as soon as practicable.
6. Defer construction of the proposed power recovery plant.
7. Continue the use of the Imhoff tanks for the treatment of West Side sewage pending further experimentation.
8. Make large scale tests to determine:—
   (a) Whether any combination of Imhoff tank treatment and chemical treatment (with or without filtration) will so improve the quality of effluent as to make further treatment unnecessary.
   (b) The cost of such treatment as compared with activated sludge treatment.

The engineers composing this Board were Daniel W. Mead, (University of Wisconsin), W. B. Storey, (Railroad Executive), Brigadier General C. W. Kutz, retired, (United States Army Corps of Engineers), and Joshua D'esposito, (PWA Engineer for Illinois). Deputy Administrator Henry M. Waite assisted the Board in its work.

Rational Storm Drain Design Practice in Los Angeles

A resume of methods employed in that city for computing the required capacity of storm drains.

A RAINFALL of one inch per hour on an absolutely impervious surface will produce an average flow of 1 cubic foot per second per acre. The formula for flow for any rate of rainfall will be:

$$Q = A R;$$

when the area in acres is A, the rate of rainfall in inches per hour is R, and the quantity of flow in cubic feet per second is Q.

No surface is absolutely impervious; all soils absorb water to a greater or less degree. If surfaces are classified as to their imperviousness, using C to designate the degree of water shedding ability which bears a relation to the percentage of runoff, the above formula becomes

$$Q = CAR$$

The intensity of the rainfall and its duration are also factors in the amount of runoff. Surfaces become saturated to an increasing degree, as the rain continues, and give forth a constantly greater percentage of the water falling upon them; also minor irregularities in surfaces become filled. Thus the runoff increases with the duration of the rain.

Percentages of imperviousness which have been assumed in Los Angeles from experience and observation are as follows:

Park areas and large estates	pervious
Suburban residential areas	30% impervious
Urban residential areas	50% impervious
Apartment house areas and suburban business	70% impervious
Commercial areas	90% impervious

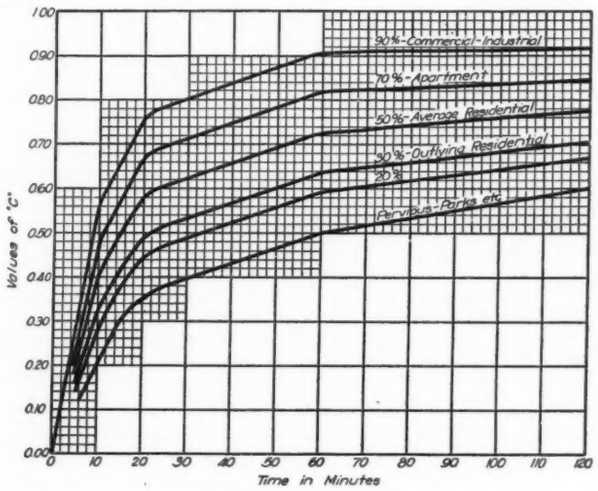
Values of C corresponding to different time intervals have been calculated from graph No. 1, which was compiled from St. Louis records, and are also shown in Tables 10-RC, 15-RC and 25-RC. The values as shown in these tables are modified to provide for the maximum run-off, which occurs at the time when the product of the variables C and R are at a maximum. The maximum runoff, if computed from the unmodified values of C from the graphs would occur later than the time of concentration (see next paragraph), if this is less than about 20 minutes for pervious areas and 10 minutes for areas of varying degrees of imperviousness. The arbitrary values of C tabulated are such that the product of CR is a maximum, using the value of R for the time of concentration of the area.

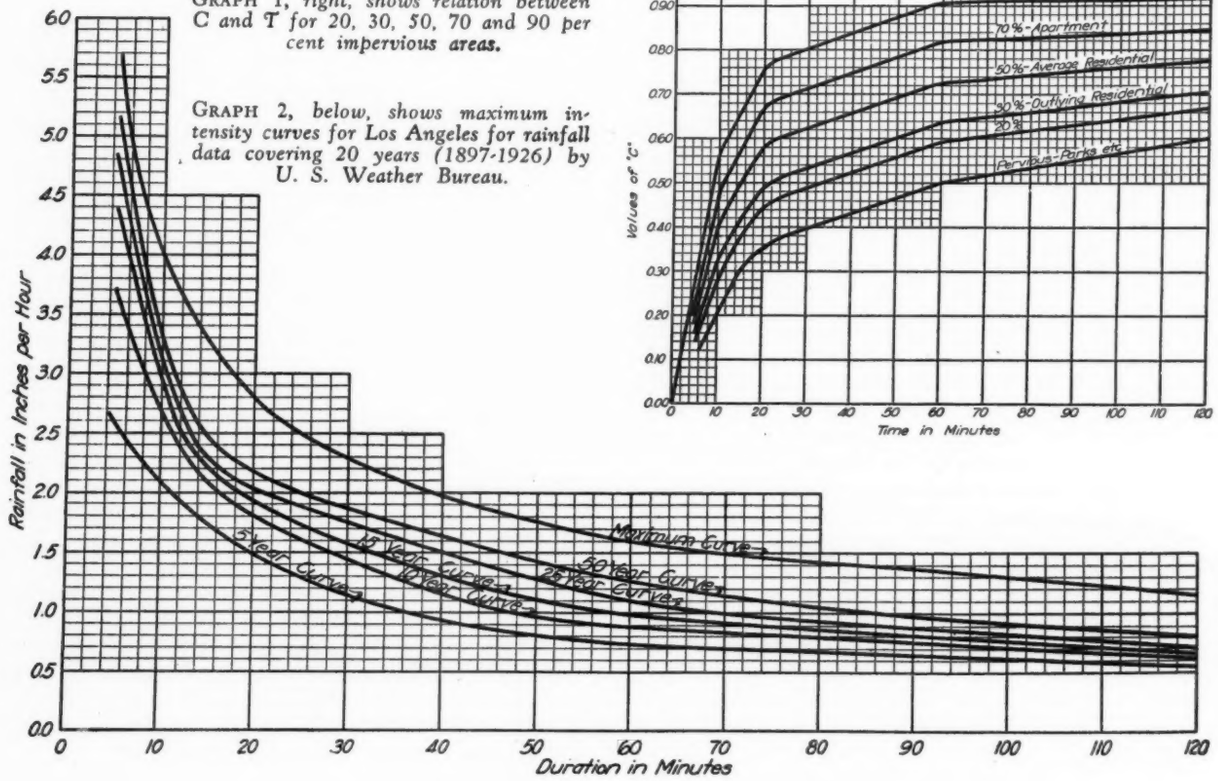
The time of concentration is the time required for a particle of storm water to flow from the most remote part of the drainage area to the storm drain inlet, with rainfall intensities corresponding to the typical storm considered. The rainfall curve shows the intensity of the

Graphs 1 and 2

GRAPH 1, *right, shows relation between C and T for 20, 30, 50, 70 and 90 per cent impervious areas.*

GRAPH 2, *below, shows maximum intensity curves for Los Angeles for rainfall data covering 20 years (1897-1926) by U. S. Weather Bureau.*





rate of rainfall for any given elapsed time. Graph 2 shows maximum rainfall intensity curves for the City of Los Angeles.

Preparation of Drainage Map

A map of the area under consideration should be drawn to a scale permitting a clear delineation of the information. As a basis for estimating coefficients of imperviousness, careful study should be made of the ultimate probable development, and maps of the Planning Commission should be studied also. Generally, it may be concluded that there is more business zoning provided for than will ever develop. Ground and street slopes also are important.

Each block should be divided into areas corresponding to different percentages of imperviousness and such information recorded on the drainage map. Pervious areas are any areas other than roofs, paved streets, sidewalks and other areas that will not absorb rainfall. A model drainage map is shown in Fig. 3, with the direction of flow in the gutters shown by arrows. The small arrows within the blocks show the direction in which runoff is assumed to reach the gutters. The percentage of imperviousness assigned to a given area of any type is the average of the whole area, including the abutting street area. The "Q" shown on the map is that calculated to reach the catch basin (or inlet) and catch basin connection and is used only in the design of these. Assumption is made that the streets shown have a cross section such that there is no overflow due to crossfall or height of crown. If there is an overflow, it must be calculated and provided for. Flow in gutters is computed on the basis of a pipe laid on the gutter grade.

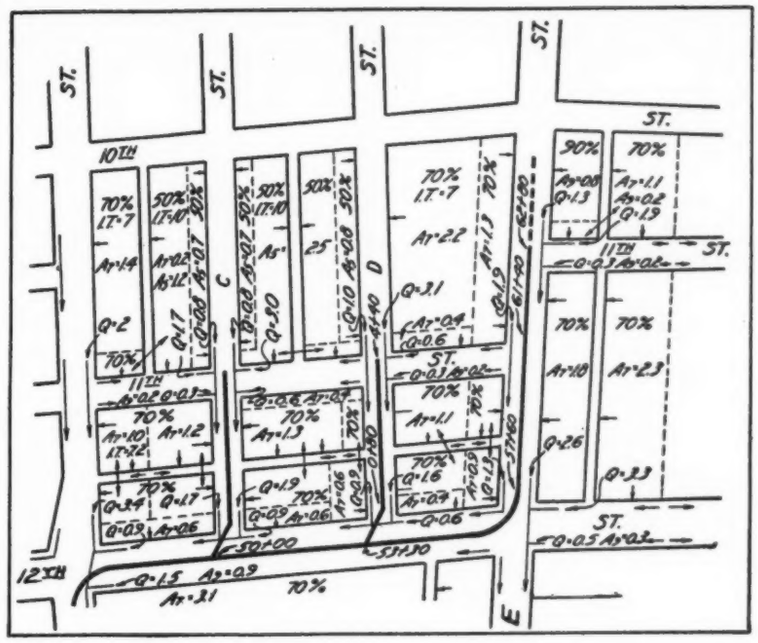


FIG. 3. *Model drainage map, for rational method of storm drain design, City of Los Angeles.*

In Los Angeles, for downtown business districts, the 15-year curve is used; for sump areas, the 25-year curve; and generally for other areas, the 10-year curve. The inlet times and percentage of imperviousness, with a gutter grade of 3% or less, are assumed from a study of all available data, as follows:

Type of Area	*Inlet Time*	*Imperviousness*
Industrial	7 minutes	30-90
Commercial	7 minutes	90
Apartment House	7 minutes	70
Well Built up City Residential	10 minutes	50
Suburban Residential	12 minutes	30
Parks and Large Estates	15 minutes	Pervious

For gutter grades of more than 3%, inlet times are:

Industrial	5 minutes	30-90
Commercial	5 minutes	90
Apartment House	5 minutes	70
Well Built up City Residential	7 minutes	50
Suburban Residential	10 minutes	30
Parks and Large Estates	15 minutes	Pervious

These values are subject to variation in the judgment of the designer. When, with two or more areas contributing, the inlet times are different, the longer inlet time is used for design.

Illustrative Example

In designing the drainage area for the district extending northerly from 10th street, along E street, as shown in Fig. 3, the assumption is made, as a start, that the elapsed time required for water to reach the catch-basin at Sta. 62+80, is 12 min. The assumption is also made that the flow from points further on will be such that CA=8. In studying Fig. 3, it will be noted that the areas, degree of imperviousness and estimated flow have been computed and are shown. A_T means an area of 70% imperviousness.

Other areas, from the South Side of 11th street to 10th street, which contribute to this line are calculated as follows:

A=1.1; IT=TT=12 min.
C (Table 15 RC, 70% impervious, 12 min.)=.52
CA=1.1×.52=.57
A (three small areas combined)=1.2; IT=TT=12 min.
C (Table 15-RC, 90% impervious, 12 min.)=.60
CA=1.2×.60=.72
Summation of CA=8.0+.57+.72=9.29
R, for 12 min., Table 15-RC=2.54
Q=(Summation CA) R=9.29×2.54=23.6 cfs.

Flow time from station 62+80 to 61+40 is 0.4 minutes. Then the rate of intensity to be used at Sta. 61+40 is 12.+0.4=12.4 minutes, or 2.46 inches per hour.

The flow entering at 61+40, in addition to the 23.6 cfs., is that from the narrow strip on the west side of E. St., between 11th and 10th Sts., which has an area of 1.3A and an imperviousness of 70%.

A=1.3; IT=TT=12.4 min.
C (Table 15RC—70% imp.—12.4 min.)=.53
R (Table 15RC for 12.4 min.)=2.46
CA=.53×1.3=.69
Summation of CA=.69+9.29 (see above)=9.98
Q=9.98×2.46=24.6 cfs.

Thus the total flow at this point for an elapsed time of 12.4 minutes will be 24.6 cfs. The time of flow to Station 57+60 is 1 minute. Continuing in this way, the flow computed as arriving at Sta. 53+30, through the sewer will be 30.4 cfs., and the elapsed time will be 14.7 minutes.

Proceeding now to the design of the lateral up D Street:

The method of calculating the approximate quantity in cubic feet per second entering the basins on D Street, north of 12th St., as shown on the model drainage map, Fig. 3, is as follows:

The area contributing is of three types: The narrow strip west of D Street and north of 11th, which has been determined to be 50% impervious; the area east of D Street, which slopes to it, which is 70% impervious; and the section of 11th Street between D and E Streets, which also drains toward this intersection, and which is 90% impervious. The IT (inlet time), as determined from the tables above, is also shown on the map.

1st Area, 0.8A, 50% impervious.

IT, 7 minutes, C (Table 15-RC, 50% impervious, 7 minutes), .32.

CA=0.32×0.8=0.26.

10-Year Curve—Table RC-10

T	R	Perv.	Values of C 30%	50%	70%	90%
5	3.6	.18	.24	.30	.36	.42
6	3.4	.19	.25	.32	.38	.44
7	3.2	.20	.27	.34	.41	.47
8	3.0	.21	.29	.36	.43	.50
9	2.84	.22	.30	.38	.45	.53
10	2.68	.24	.32	.40	.48	.56
12	2.4	.26	.36	.44	.52	.60
14	2.17	.29	.40	.48	.56	.64
16	2.0	.32	.43	.52	.60	.68
18	1.89	.33	.46	.55	.63	.72
20	1.80	.35	.49	.58	.67	.76
25	1.62	.38	.52	.61	.70	.79
30	1.45	.40	.53	.62	.71	.80
35	1.29	.42	.55	.64	.73	.82
40	1.15	.43	.57	.66	.75	.84
50	0.98	.47	.60	.69	.78	.87
60	0.89	.50	.64	.73	.82	.91
70	0.84	.52	.65	.73	.82	.91
80	0.80	.53	.66	.74	.83	.91
90	0.76	.55	.67	.75	.83	.91
100	0.72	.57	.68	.76	.84	.91
120	0.63	.60	.71	.78	.85	.92

15-Year Curve—Table RC-15

T	R	Perv.	Values of C 30%	50%	70%	90%
5	4.25	.16	.22	.28	.33	.39
6	3.98	.17	.24	.30	.36	.42
7	3.72	.18	.26	.32	.38	.45
8	3.46	.20	.27	.34	.41	.48
9	3.20	.21	.30	.37	.44	.52
10	2.96	.23	.32	.40	.48	.56
12	2.54	.27	.36	.44	.52	.60
14	2.29	.29	.40	.48	.56	.64
16	2.13	.32	.43	.52	.60	.68
18	2.02	.33	.46	.55	.63	.72
20	1.93	.35	.49	.58	.67	.76
25	1.75	.38	.51	.60	.69	.78
30	1.57	.40	.53	.62	.71	.80
35	1.44	.42	.55	.64	.73	.82
40	1.31	.43	.57	.66	.75	.84
50	1.11	.47	.60	.69	.78	.87
60	1.00	.50	.64	.73	.82	.91
70	0.92	.52	.65	.73	.82	.91
80	0.87	.53	.66	.74	.83	.91
90	0.81	.55	.67	.75	.83	.91
100	0.76	.57	.68	.76	.84	.91
120	0.67	.60	.71	.78	.85	.92

25-Year Curve—Table RC-25

T	R	Perv.	Values of C 30%	50%	70%	90%
5	4.65	.15	.22	.27	.32	.38
6	4.31	.16	.23	.29	.35	.41
7	4.00	.18	.25	.31	.38	.44
8	3.70	.19	.27	.34	.41	.47
9	3.37	.21	.30	.37	.44	.52
10	3.13	.23	.32	.40	.48	.56
12	2.68	.26	.36	.44	.52	.60
14	2.38	.30	.40	.48	.56	.64
16	2.22	.32	.43	.52	.60	.68
18	2.09	.34	.46	.55	.63	.72
20	2.02	.35	.49	.58	.67	.76
25	1.88	.38	.52	.61	.70	.79
30	1.76	.40	.53	.62	.71	.80
35	1.63	.42	.55	.64	.73	.82
40	1.50	.43	.57	.66	.75	.84
50	1.27	.47	.60	.69	.78	.87
60	1.10	.50	.64	.73	.82	.91
70	0.99	.52	.65	.73	.82	.91
80	0.93	.53	.66	.74	.82	.91
90	0.88	.55	.67	.75	.83	.91
100	0.82	.57	.68	.76	.84	.91
120	0.72	.60	.71	.78	.85	.92

2nd Area, (2.2+0.4) 2.6 acres, 70% impervious.
IT, 7 min., C (Table 15-RC, 70% impervious, 7 min.), 0.38.
CA=0.38×2.6=0.99.
3rd Area, 0.2 A, 90% impervious.
IT 7 min., C (Table 15-RC, 90% impervious, 7 min.), 0.45.
CA=0.2×.45=0.09.
Summation: CA=0.26+0.99+0.9=1.34.
R (Table 15-RC, 7 min.)—3.72.
Q=(Summation CA) R=1.34×3.72=5.0 cubic feet per second flow.

The design for a flow of 5 cfs. gives a time of flow from this point (Sta. 4+10 to St. 0+80), of 1.2 minutes. Here four areas, totaling 2.1 acres, each 70% impervious, contribute. The total time (TT) to this point is 7 minutes plus 1.2 minutes, or 8.2 minutes. Computations are now carried on in the same way for these areas, using a value of 8.2 minutes in Table 15-RC.

When these computations have been made, it will be seen that the total flow entering the main line at Sta. 53+30 will be 7.6 cfs., and that the total time required for the storm water to reach this point will be 8.4 minutes.

However, the time required for the maximum flow to reach Sta. 53+30 through the main drain from Sta. 62+80 will be 14.7 minutes. Consequently, in the case of a rainfall of less duration, the maximum flow from the lateral on D Street will have passed. Therefore, while the size of the D Street lateral must remain sufficient to carry 7.6 cfs., the main sewer on 12th Street need not be designed to carry this additional volume. Instead, the contribution by the lateral to the main must be recomputed, using as a time basis 7.0 minutes + (14.7—8.4), or 13.3 minutes.

Using 13.3 minutes for IT, instead of 7 minutes, and recomputing on the basis of this time period, the flow will be found to amount to 7.0 instead of 7.6 cfs. from the D Street lateral at Sta. 53+30.

On the basis of the 14.7 minutes and the resulting rainfall as shown, in Table 15-RC, of 2.23 inches, the line leaving Sta. 53+30 must be designed to carry 35.8 cfs.

The tables herewith, RC-10, RC-15 and RC-25, have been prepared from those used by Los Angeles, but fractions of minutes have been omitted. In general, interpolation is possible without appreciable error.

In carrying out the work, it is desirable to prepare a sheet with columns for each item, as follows: 1, station; 2, length; 3, elevations; 4, name of area; 5, per cent impervious; 6. area; 7, *C;* 8, *CA;* 9, summation *CA;* 10, rainfall intensity; 11, *Q;* 12, slope of sewer; 13, size; 14, velocity; 15, elapsed time; 16, street and limits.

Principles for Evaluation of Highway Systems

R. W. Crum, Director, Highway Research Board

There are many factors both social and financial that enter into the evaluation of a system of general use roads, but the starting point for a study of values is a determination of economic factors such as the relations between annual cost, annual earnings, and savings due to improvements.

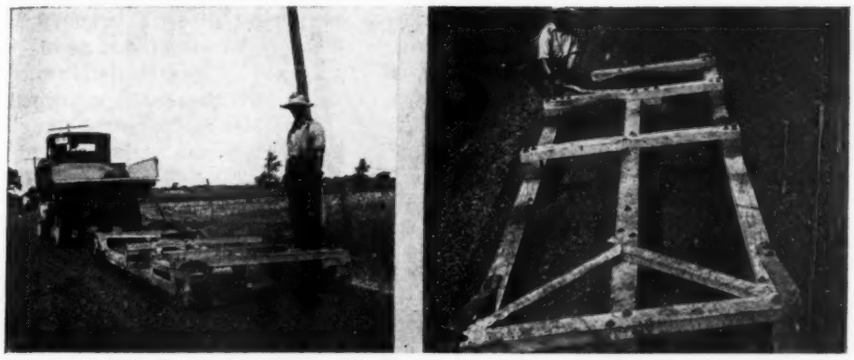
The road system is regarded as a public utility which offers certain facilities to the public and which costs certain sums annually to provide. The users pay for this service through charges collected by the state in the form of license fees and taxes on gasoline. A balance sheet can be struck for the system by comparing these two, and the reasonableness of the rates can be studied through the relation of the highways provided to the costs of operating vehicles over them.

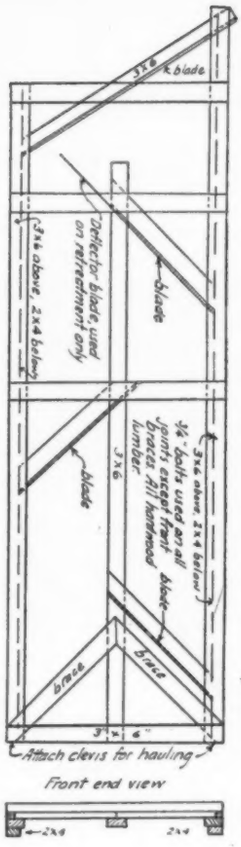
If the earnings of the highways at equitable rates are equal to or exceed the annual cost of providing the roads, the system is sound financially, and if the cost of transportation is as low as is consistent with adequate service it is economically sound.

Mechanical Finisher Used on 50-Foot Asphalt Concrete Pavement

A 50-foot asphalt concrete pavement has been completed on North Los Angeles St., Anaheim, Calif., over a length of one mile. On a portion of the job, the asphalt concrete was laid to a thickness of 2 inches. On the remainder it was 7 inches, decreasing to 6 inches in the outer 5 feet. Portland cement gutters 3 feet wide were added, giving a total width of 56 feet. The asphalt concrete was laid on a Portland cement concrete base.

Laying of the surface was done in two strips, each 25 feet wide, using about 50 men, a 3-wheel, 12-ton roller, two 8-ton tandem rollers, and a 25-foot mechanical finisher. About 7,600 tons of asphalt paving material were placed at a contract price of $3.63 per ton. H. B. Lindley acted as resident engineer for the State Highway Department, under S. V. Cortelyou, district engineer.





Vermont Gravel Drag

This drag, known as the Vermont State Highway Dept. Gravel Drag No. 4, with zigzag type adjustable blades, consists of a hardwood frame, carrying blades of standard blade steel and shoes of cast steel. The frame consists of two side sills 18'6" x 3" x 6" on two sills 18'6" x 3" x 4"; connected by four cross-pieces, three 6' x 3" x 6" and one 6' x 3" x 8". Running through the center is a beam 16' x 3" x 6"; between this and the side beam run three diagonal blade beams, 4'9" x 3" x 6", while at the rear is a fourth diagonal blade beam extending entirely across the drag, 6'11" x 3" x 6". Between the front corners and the central beam are two braces 4' x 2" x 4". In addition there are 32 filler blocks. The frame is carried on four shoes 3' long, one at each corner, extending 3" below the sill. To the front of the sills are bolted two draw irons 4'2½" x 4" x ½". There are four steel blades, three 4'3" x 6" x ½" and one 6'6" x 8" x½". The entire drag is bolted together, using 97 bolts ¾" diameter.

Building Vermont Mixed-in-place Road

By Harold L. Tilton
District Highway Commissioner
Vermont Department of Highways

IN this article will be described a mixed-in-place road built in Richford, Vermont, with the use of a very simple and inexpensive aggregate plant. As the project was only two miles long, it was imperative to avoid the overhead that would result from the rental charges for elaborate equipment. There was no commercial source of aggregate available and the problem was to produce aggregate of the highest quality and to do so with a small plant of low cost.

The aggregate selected was a river gravel from a bar in the Mississquoi river, which runs alongside the road which was to be constructed. The percent of wear of this gravel was 16.5. A dry summer and low water made it easily accessible. High water stopped operations for only a few days during the entire construction period.

Other bars in the river contained gravel which was composed mostly of cobbles ranging in size from one inch in diameter up to about six or eight inches. This material was used to construct a gravel sub-base throughout the length of the project. Most of the sub-base was twelve inches in depth.

The bar selected for the surface aggregate contained material ranging from sand to stone about two inches in diameter, with about twenty percent of oversize stones.

The gravel was excavated by a Wilford shovel of three-eighths cubic yard capacity, running on caterpillar treads. The shovel loaded it into trucks which cruised up and down the river and across a ford, by keeping to the sections where the water was shallow. This was perfectly feasible, as the bottom of the stream was of gravel. In this manner the gravel for both sub-base and surface was excavated and hauled to the road.

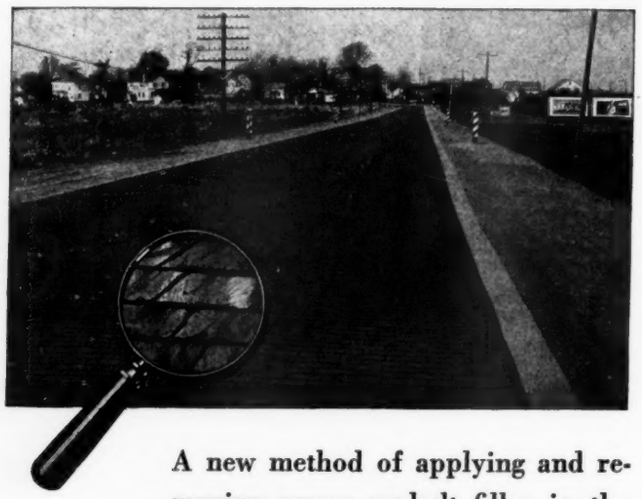
The gravel was a schist and therefore contained stones of varying shapes and composition. It was well graded and had a small percentage of oversize stones. Accordingly it was decided that the expense of a crusher could be eliminated and the desired sizes be obtained by screening only. The plant consisted simply of a second-hand Barber-Greene portable bucket-elevator loader. This, as will be seen in the illustration, was set up on cribwork at the edge of the road, which was about eight feet above the adjoining meadow at that point and close to the river. The gravel was dumped into a hopper and elevated by the buckets onto a series of flat screens set at varying slopes. The first screen section consisted of ¼ inch wire mesh. At this point the gravel was washed by a spray from two perforated two-inch pipes. A centrifugal pump supplied the water. The next screen was a ¾ inch mesh. Following this was a grill of second-hand one-inch pipes set 1¾ inches apart. Small wood bins of two cubic yards capacity were built under each screen and retained the aggregate while the truck made a trip to the stockpile and returned for another load. The bins were made portable and can be easily carried away on a truck.

The sand was not used on the project but was stored for maintenance retreatment for nearby roads. The oversize material was used in the sub-base, as the plant operation was started early enough to make this possible while stockpiling the aggregate for the surface. Thus the surface aggregate consisted of two sizes; the peastone, ¼"-¾", and the stone for the mix, passing the 1¾" grill and retained on the ¾" mesh.

The screens were so arranged that the slope of each could be varied at will. It was necessary for five or six men with hoes to keep the screens clear, with a production of about 200 cu. yds. of sand and screened stone per day. This was satisfactory, as wages were low and it was desired to provide work for as many men as possible.

The method of constructing the surface was as fol-

AN IMPROVED TECHNIQUE IN APPLYING FILLER



A new method of applying and removing excess asphalt filler in the construction of brick pavements has been increasingly employed with excellent results during the last two years.

A dilute "separating" mixture is sprayed on the brick which prevents adhesion of the asphalt to the top of the brick, where it is not needed, but allows a perfect asphalt bond between the sides of each brick. The excess asphalt is cut cleanly from the top of the pavement and is then re-used. Note the cleanness of the surface of this finished job and the excellent non-skid value thus obtained.

This new technique contributes to the ease of construction, as well as to developing the best traffic qualities of the pavement.

Detailed specifications for this method are available from National Paving Brick Association, National Press Building, Washington, D. C.

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lows. First, the gravel sub-base was compacted and brought to a true grade and given a prime coat of medium curing cutback asphalt designated as MC1 by the Asphalt Institute. (Incidentally in the future, on bases of this type, R.C. 1 will be used as a prime and will be much more satisfactory.) The coarse stone was then spread by a mechanical spreader to a depth of two inches. It was given an application of rapid-curing cutback asphalt at the rate of 0.8 gal. per sq. yd. The type used was that designated by the Asphalt Institute as R.C. 2, which had an average viscosity Furol at 122 degrees F. of 300, and a penetration of the residue of 95-110.

Mixing was done by a wood drag 20 ft. long with steel zig-zag blades. The drag was drawn by a four-wheel-drive truck. After the aggregate had been thoroughly mixed, it was shaped and smoothed by a road machine and immediately rolled sufficiently to cover the surface but once. Peastone was then spread in sufficient quantity to key and fill the voids. Back rolling followed on succeeding days, using a 12-ton Acme gasoline roller.

After the mix course had thus been completed, the surface was then swept clean and a seal of R.C. 2 was applied at the rate of one-third gallon per square yard. This was immediately covered in quantity just sufficient to fill any remaining voids and to true any small irregularities. By the use of the same drag, with the blades set slightly higher than the shoes, the stones were coated with asphalt and placed precisely where needed. A light covering of dry peastone was then applied and the surface rolled to a limited extent to avoid crushing the peastone. Further compaction of the seal was left to traffic. The cost of the work, including base and drainage, was approximately $10,000 per mile. This type of finish presents a non-skid surface of pleasing appearance and the cost of maintenance should be low.

For Greater Safety on Ohio Highways

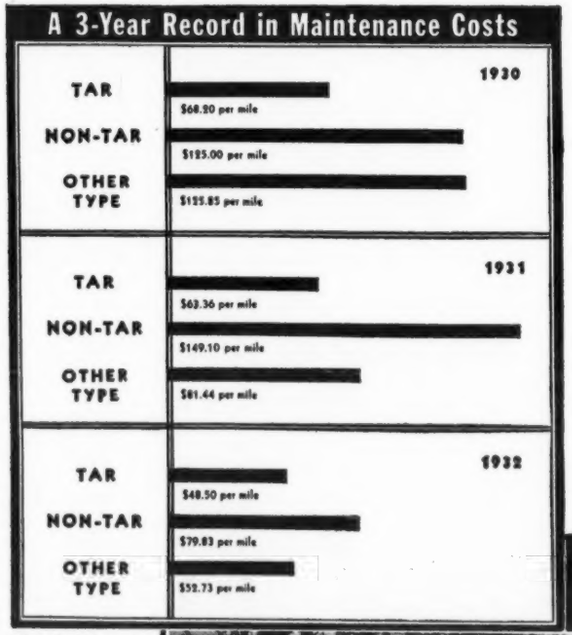
For the past year the bridge bureau of the Ohio Highway Department has been engaged in a series of progressive steps to eliminate many inadequate structures on the state system. During 1934 this work will be pursued with special intensity and the elimination of weak structures will be dependent entirely upon the availability of finances to cope with this project. Similar studies and a corresponding stride in elimination of dangerous railroad crossings through the medium of overheads, under-passes and similar safety structures have been pursued.

The maintenance and repair bureau of the department by application of modern and efficient operations is undertaking many practical safeguards for the motoring public. There is now underway a rather extensive campaign to eliminate the most dangerous "slippery" pavements, preservation of berms, upkeep of "hill stretches" and similar situations. During 1934 the maintenance department plans to continue these "safety measures."

C. W. A. Relieves 40,000 Los Angeles Families

Los Angeles County, California, was relieved of the care of 40,000 families by C. W. A. operations last winter. During September, October and November the County's expenditures for relief were $1,378,000, $1,470,000 and $1,347,000 respectively. During the next three months the costs were reduced by C. W. A. to $594,000, $799,000 and $898,000 respectively; then jumped to $1,556,000 and $1,568,000 in March and April.

FOR YEAR-AFTER-YEAR ECONOMY DEPEND ON TAR



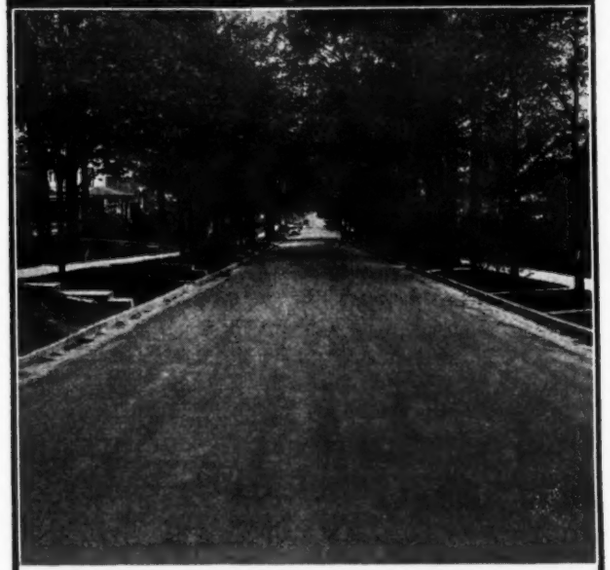
This chart based on actual cost data of City of Grand Rapids.

The chart on this page shows the actual figures on maintenance costs for 228 miles of streets in the City of Grand Rapids, Michigan. Three types of paving are included.

Many of the tar treated streets are 15 to 20 years old and are in splendid condition. On the other hand, many of the non-tar bituminous streets that have been in service shorter periods than that have had to be replaced.

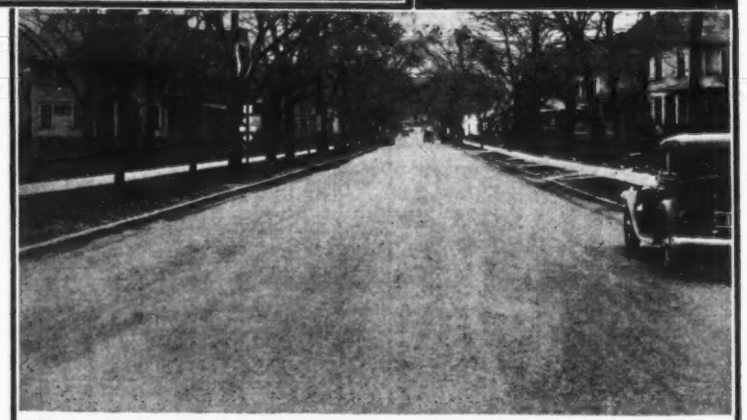
Grand Rapids has found that it not only costs less to maintain its Tarmac streets, but they last longer. Figures under each of the photographs on this page show the volume of traffic these streets carry.

Tarmac-Sealed 6 Years Ago—Carries 6,500 Vehicles



College Avenue, Grand Rapids, Mich. Built in 1914. Cobble foundation with 3-inch broken stone base course and 2-inch tar penetration course. Resealed in 1928 at cost of 6c per sq. yd. 1933 average daily traffic: Trucks and cars; 6,524.

Tarmac Seal Coat Costing 6c Sq. Yd. —Carrying 12,000 Vehicles



This photograph shows Lake Drive, east of Fulton, Grand Rapids. Cobble stone street built in 1909, graveled, compacted, primed and sealed with tar in 1914 at cost of 35c per sq. yd., exclusive of graveling. Tarmac seal treatment, costing 6c sq. yd., in 1933. Previous seal treatment, 1929. 1933 average daily traffic: Trucks; 1,230. Cars; 11,467. Total; 12,697.

FOR TAR DEPEND ON KOPPERS

Tarmac

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NRA CODE

Pages 28, 60 and 61 contain descriptions of many helpful booklets—Don't forget to look them over.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

A PARSHALL measuring flume with a 10-foot throat is used in the Providence sewage disposal plant—by far the largest of this type yet used.[B6-1] "It has shown itself to be sensitively responsive to small changes in ratio of flow" varying from 5 to 120 mgd, and two comparisons with weir measurements showed differences of 0.19% and 0.26% respectively. This device is now widely used in Western irrigation districts with capacities of from 0.5 to 2600 cfs. The loss of head is only about ¼ that of the usual weir. In the Providence flume a 2½ in. brass pipe leads from each side of the throat to a common float well. For recording, a Builders Iron Foundry Type Y register-indicator-recorder, specially modified, is used, operated by a 24-in. diameter float, which has a travel between 0.5 and 2.7 ft.

Rainfall curves are of a temporary nature and must be revised from time to time if they are to remain reasonably accurate in view of all existing data.[K6-2] This is illustrated by the two curves showing yearly changes in 5-year and 10-year storms as recorded in Central Park, New York, rainfall records. Assuming the rates to be computed at the end of each calendar year, "In 1910 one would have said that a reliable 5-year rainfall curve could be obtained from a 42-year record; yet, if such a curve had been computed in that year, it would have been badly in need of revision by 1913, as changes in the data were nearly as great as the difference between the author's 5-year and 10-year curves."

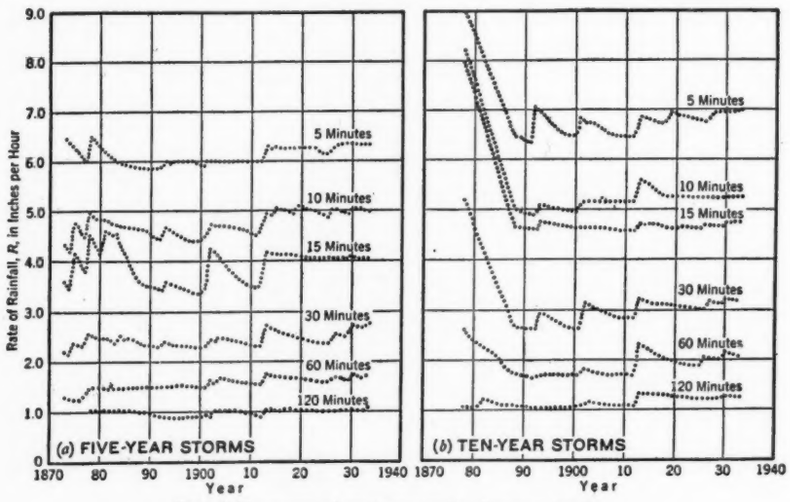
Shaft sinking 51 feet to a sewer tunnel in Cleveland, Ohio, was performed by the Gallagher & Burke Construction Co. in an unusual way.[R5-1] A circular shaft was sunk 12 ft. diameter, using 10" planks for sheeting and steel tunnel liner plates as wales. The top sheeting was 16' long; the next, set on an 11' circle, was 12' long. These passed through loam, sand and gravel. Plastic blue clay was found at about 23 ft. and from there down, 4' wood lags were used, with liner plate rings at the joints of successive lagging courses. The liner plates were ¼" thick, 16" wide and 37 11/16" long, with 2" flange; twelve of them giving a 12' circumference and eleven of them an 11' one. These rings were spaced 4' apart vertically.

Coarse screenings (totaling 173.5 cu. yd. in 1933) at Schenectady, N. Y., are plowed under the soil.[C5-8] "It was found possible to re-use the plowing ground used three years ago because of the rapid conversion of these solids into humus."

Cost of treatment at Schenectady for 1933 totaled $20,300, equivalent to $6.22 per million gal. treated.[C5-8] Of this, $3.87 was for labor; 63c for supervision, laboratory and control; 26c for light, power and heat; 15c for repairs, 18c for supplies; 10c for replacement and purchase; 78c for taxes, and 25c miscellaneous. Of the labor costs, $1.28 was for the Imhoff tanks, 20c for trickling filter, 12c for control, 13c for bar rack and screenings, 74c for sludge drying beds, 74c for night attendance and cleaning, and 66c for maintenance and repairs.

Technical control of sewage treatment has proved its value at Schenectady, N. Y. Said Morris M. Cohn:[C5-8] "The design of the proposed new works on the basis of data collected by the writer has saved the city of Schenectady many thousands of dollars because complete technical knowledge of sewage and flow characteristics, digestion variations, stream conditions, and abilities and limitations of existing facilities, has made possible more intelligent solution of the problem." The availability of the data was due to "record keeping, laboratory control, sanitary perfection, difficult research" and other phases of works operation.

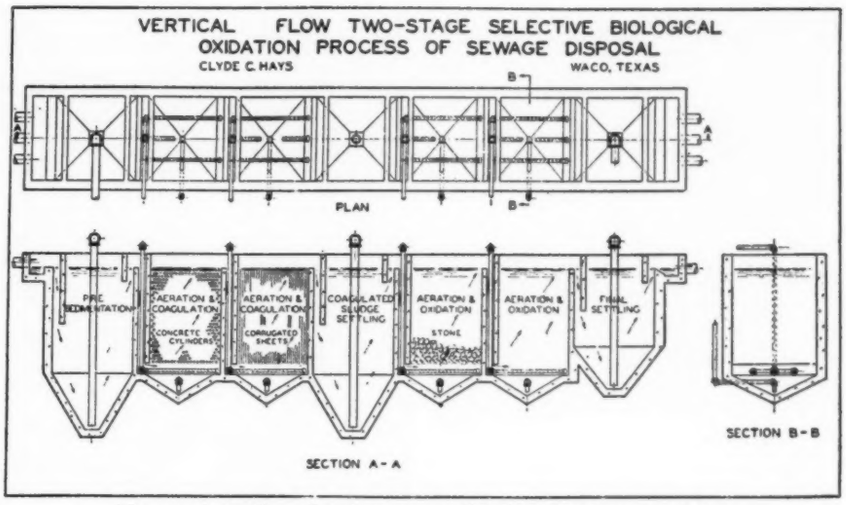
Sewage plant data of Aurora, Ill., for 1933[E6-1] show reduction of BOD from 123 to 23 ppm by sedimentation and trickling filters. Population served, 47,000. Average flow, 6.6 mgd; maximum flow, 9.8; rated capacity of plant, 6.5. Sludge digestion tanks have hot water coils and mechanical agitation. Gas collected and used in incinerator to burn screenings. Cost of plant $675,000; includes a fine screen, automatic cleaning, float controlled; grit chamber cleaned by revolving scrapers; 4 sedimentation tanks, 50 x 50 x 10, sludge removed by revolving scrapers; trickling filter 586 x 274 x 6; 3 digestion tanks 50 x 50 x 16.5; 10 sludge beds, each 125 x 40.



Rainfall curves showing yearly changes in data

Mechanical flocculators were installed last year for the first time in England, at the Halifax sewage works settling tanks "for the purpose of increasing the efficiency of chemical precipitants and coagu-

lants."[D6-5] This flocculator consists of "paddles that slowly revolve underneath the sewage at the inlet end of the tank. Gentle agitation builds up the precipitated floc particles into larger and denser forms, and it is said that the apparatus has improved the efficiency of the tanks as regards removal of suspended solids by more than 15 percent when using an acid precipitant (vitriol)." Effective precipitation of sewage involves both thorough mixing and a time factor to permit maximum coagulating effects.



Plan and section showing new oxidation treatment process

A sludge digestion tank 80′ diameter and 27′ deep is the chief feature of a treatment plant recently adopted for Sutton, England,[D6-3] for a population of 80,000, estimated to cost £ 12,500. The sludge will be pumped from the sedimentation tank through 1¾ mi. of 8″ c.i. pipe to the digestion tank. The local gas company has agreed to take the gas generated. A slow stirring mechanism will be used, and the tank heated by hot water coils.

Digestion tanks at Winterswyk, Holland,[H6-3] three in number, each contains a series of wooden racks to mix the incoming sludge with the ripe material, stir the contents gently and break any scum formation. They are rotated for scum breaking and mixing, after fresh solids have been introduced, for a period of 10 minutes every 24 hours. One tank has a floating cover of iron which, when in operation, is covered with a sheet of water.

A small activated sludge tank, for an institution population of only 265 persons, is in use at an insane asylum near Apeldoorn, Holland.[H6-3] Brush aeration is employed. Applied sewage strong and brown, with considerable H_2S odor; effluent very clear, 5-day BOD, 13. Power consumed to drive brush aerator and return activated sludge, 12 kwh per day.

A new oxidation sewage treatment process has been developed at the Waco, Texas, plant.[CC6-1] It consists of plain sedimentation, the effluent passing through two or more aeration and coagulation tanks; then through a coagulated sludge settling tank; then into oxidizing tanks, and then to a final settling tank. All tanks receive diffused air through tubes at the bottom. The first set of tanks contain surfaces such as tile, concrete slabs or concrete cylinders, on which grow "sulphur-splitting or slime producing organisms" which "precipitate the colloids and remaining suspended solids." Here the air provides these with oxygen and also prevents the sludge from accumulating on the surfaces. The sewage remains in these tanks 45 to 60 min.; and 40 to 50 min. in the settling tank. The oxidizing tanks are of the same design as the coagulation tanks but contain a different group of organisms. The sludge produced is small in quantity; that from the first stage of the process is heavy and thick, that from the second stage has the appearance of well-oxidized sludge and is somewhat lighter than the other. Both dewater very quickly on drying beds. The amount of air required averages 1.5 to 1.75 cu. ft. per gal. of sewage treated. It is estimated that a plant for 500,000 gpd would cost $7,500.

Bibliography of Recent Sewerage Literature

c, Indicates construction article; *n*, note or short article; *t*, technical article.

D — *The Surveyor*
6 — *April 20*
1. The Value of Chlorine in Sewage Disposal, p. 445.
2. Recent Advance in the Chemical Treatment of Sewage. By F. W. Mohlman, p. 451.

May 4
3. Sewage Treatment at Sutton and Cheam. By Wm. H. Grieves, pp. 493-494.

May 11
4. The Measurement of Sewage, p. 512.
5. Rivers Pollution Prevention in an Industrial Area, pp. 515-517.
6. Recent Developments in Sewage Treatment, pp. 517-518.
7. Leek's New Main Outfall Sewers and Sewage Disposal Works, pp. 521-522.

E — *Engineering News-Record*
6 — *May 10*
1. Sewage Plant Survey: Aurora, Ill., p. 596.
2. Modified Program Proposed for Chicago Sewage Treatment, pp. 641-643.

G — *Water Works and Sewerage*
6 — *May*
1. Dewatering Sewage Sludge by Vacuum Filters at Hagerstown, Md. By Wellington Donaldson, pp. 139-144.
2. Special Design for Separate Sludge Digestion. By Henry W. Taylor, pp. 148-150.
3. Equipment for Water and Sewage Laboratories. By Thomas M. Riddick, pp. 151-153.

H — *Municipal Sanitation*
6 — *May*
1. Proper Sanitation of Tourist Camps Presents Many Problems, pp. 153, 165.
2. Sanitary Engineering as a Vocation. By Chas. Gilman Hyde, pp. 154-155, 170.
3. Sewage Treatment Developments in Continental Europe. By Willem Rudolfs, pp. 159-165.
4. Liability of Municipalities for Obnoxious Odors. By Leo T. Parker, pp. 166-167, 170.
5. Licensing Sewage Plant Operators. Symposium, pp. 168-170.

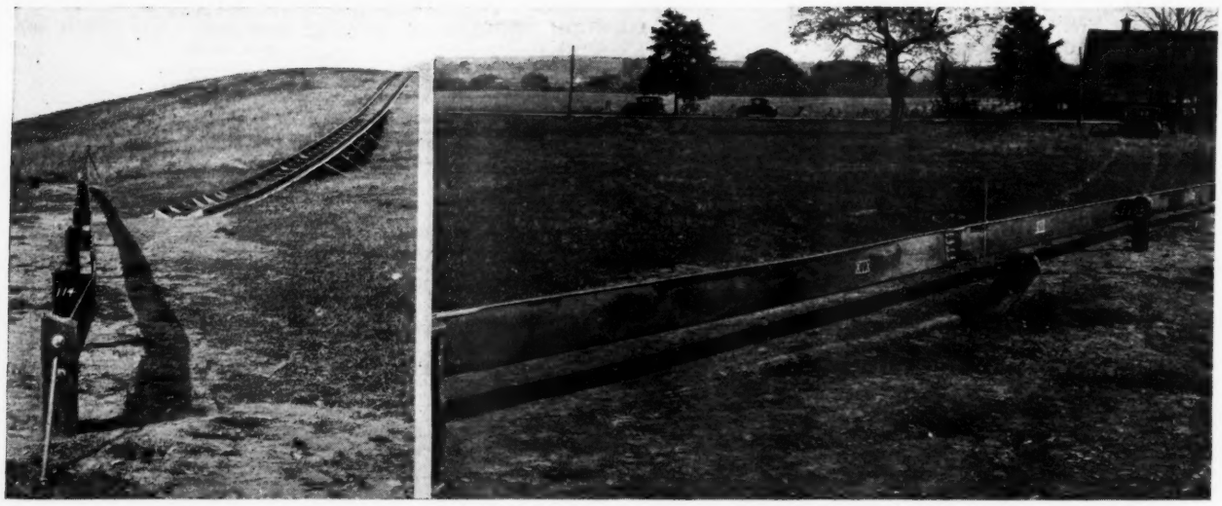
J — *American City*
6 — *May*
1. Description of the Sewage Treatment Plant at Flint, Mich., pp. 46-49.

K — *Proceedings, American Society of Civil Engineers*
6 — *May*
1. Loss of Head in Activated Sludge Aeration Channels. Discussion by Henry R. King and M. H. Klegerman, pp. 734-739.
2. Rainfall Studies for New York. Discussion by H. A. Foster, J. J. Slade, C. W. Sherman, M. M. Bernard, Clifford Seaver, J G. Montes, pp. 740-753.

P — *Public Works*
6 — *May*
1. *c.* Building Sewers Under Difficult Conditions. By F. C. Zeigler, pp. 9-10.
2. *n.* Gas in Sewer Kills Two, p. 16.
3. Sewage Treatment Works in Ohio, p. 44.
4. Drying and Incineration of Sewage Sludge. By Alden E. Stilson, pp. 14-16.

S — *Construction Methods*
6 — *May*
1. *c.* Reconstruction of Sewage Plant Gives Winter Employment, pp. 46-47.

CC — *Southwest Water Works Journal*
6 — *April*
1. Application of Oxidation Principles to Small Town Sewage Disposal Plants. By Clyde C. Hays, pp. 12-14.
2. Selection of Deep Well Pumping Equipment. By R. E. Swanson, pp. 9-11.



To complete the development of the "Tyton" rail, a series of tests were made under the direction of the Pittsburgh Testing Laboratory, trucks being run down a plank runway 335 ft. long with a drop of 43.79 ft., the trucks attaining an average speed of about 30 mi. per hr., running without power. This runway is shown in the left photograph above. On the right is shown a "Tyton" rail which has been struck by a Marmon truck, weight 4450 lb., speed at impact 30 mph. It struck between posts 5 and 6, followed the rail to post 6, which was mashed to the ground, and then was deflected by the rail and coasted 200 ft. into the field, as is seen in the photograph. Damage to car, front hub cap knocked off, bumper bent, front tire blown out. Damage to guard, one demolished post and a panel of rail requiring a slight amount of straightening.

Protecting Traffic at Danger Spots on Highways

THE first guard rails used after the advent of the automobile were wooden plank or squared or unsawed timber supported on wooden posts. Then some old cables strung through holes in posts were used. New and stronger cables replaced the trial makeshifts, and, with improved post connections and anchorage, cables are still used. Later, wire mesh and wire fabric of several designs were placed on the market; followed by wire tapes. The latest development is the steel plate 10″ or 12″ wide.

Some general ideas relative to the purpose of guard rails and their location were given in the May issue of PUBLIC WORKS. Discussing these more at length; the primary purpose of the guard rail was to keep vehicles from leaving the road; but it is realized now that it is equally if not more important that it be plainly visible at all times, to show the driver where the edge of the road lies, allowing him to concentrate his attention on the other driving hazards, and to indicate the presence of dangerous curves, culverts or bridge approaches.

The guard rail should be located as far as possible from the edge of the pavement but not so near the edge of the roadway as to result in insecure post setting. It should be used on all embankments where it seems probable that a vehicle which leaves the roadway will overturn; this depending on height of embankment, steepness of slope and width of shoulder. It should be used to guide traffic to headwalls of culverts and the entrance to bridges in such a manner as to eliminate danger of coming into contact with the bridge rail or truss or the culvert headwall. It should be constructed on the outer side of all curves where the radius is considered short enough to warrant super-elevation of the roadway. Where the width of road between guard rails is greater than that between culvert headwalls or than the width of a bridge roadway, the width should be narrowed gradually, about one foot to 16 feet longitudinal distance.

The characteristics desired are: Ability to prevent vehicles from leaving the road, and to do as little damage as possible to the vehicle and receive as little itself should it be struck by one; visibility by day and especially by night; durability; appearance; low construction and maintenance cost.

In a recent paper before the Purdue Road School, P. J. Freeman, consulting engineer with the Pittsburgh Testing Laboratory, said: "From personal observation covering a period of years, it is the belief of the writer that the necessity for keeping the vehicle away from contact with the posts is very obvious, and it seems equally obvious that the most satisfactory results will be obtained from highway guard rail in which end anchorages are used, having sufficient rigidity to utilize the full strength of the guard rail throughout its entire length, rather than depend on the resistance of heavy posts."

The former is effected by various forms of offsets to hold the guard several inches away from the posts. Most of these are provided with springs to absorb the shock of vehicle impact. Contact of wheel hub with post may wreck the vehicle when otherwise it might escape with practically no damage. Apparently the ideal guard will, if struck by a vehicle, yield somewhat under the impact and guide the vehicle along the face of the guard with no obstruction more destructive than friction. This requires the guard to be at the proper height (see PUBLIC WORKS for May, page 26) to receive the impact from the wheel hub itself or the bumper, and

to present no obstacle to the sliding of same along its surface.

A plank set with the middle of its face 17" above the ground would serve the purpose fairly well, but might break under the impact from a truck, and the splinters might do serious injury to vehicle or driver. Steel bands are now being used in place of planks.

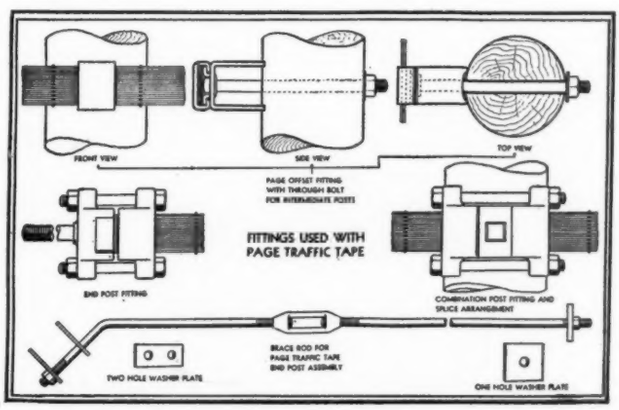
Types of Guards in Use

Where wire cables are used, there are generally two, about a foot apart vertically. The size of cable is usually ¾ inch, galvanized steel, 15,000 lbs. minimum strength. These are anchored to a deadman at each end and supported at each post, preferably by an offset bracket. A turnbuckle or other means is provided at the anchorage for drawing the cables taut. Offset brackets, cable anchors, splicing connections, etc., can be obtained from a number of firms.

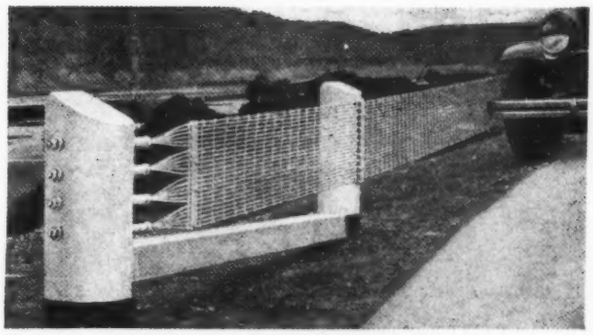
Instead of attaching the cables to fixed posts, they may be carried by equalizers, which in turn are pivoted on a support which yields backward about 6 inches against heavy springs, which tend to return it to its original position; this device being known as the "Ramsey safety guard rail."

To provide better visibility than the cable offers, increase strength and flexibility and decrease damage to vehicles, is the purpose of the "Page traffic tape." This uses the same number and size of wires as are used in a ¾" cable, but combines them into a band 2½" wide and one wire thick. It weighs approximately 87 lb. per 100 lineal feet; is galvanized, and is attached to any post with an offset fitting which supports it about 4" from the post. Anchor rods and splice fittings also are necessary. These tapes are hot-galvanized and are easily painted for greater visibility when desired.

The Pittsburgh Safety highway guard (Pittsburgh Steel Co.) consists of a band 14 inches wide, made of twenty-four 8-gauge spring steel wires of high tensile strength, woven in and out with vertical stay wires which have been crimped to give the longitudinals the proper spacing. The tensile strength of the longitudinal wires is approximately 200,000 lb. per sq. in., giving the band a breaking strength of 50 tons; and the elastic limit is almost equal to the ultimate strength. The band is mounted directly on round wooden or steel posts spaced 16 ft. apart and securely anchored at each end by means of locking sleeves to a substantial anchorage. It has high visibility due to its width and heavy galvanized finish.


FRONT VIEW
SIDE VIEW
TOP VIEW
PAGE OFFSET FITTING WITH THROUGH BOLT FOR INTERMEDIATE POSTS
FITTINGS USED WITH PAGE TRAFFIC TAPE
END POST FITTING
COMBINATION POST FITTING AND SPLICE ARRANGEMENT
BRACE ROD FOR PAGE TRAFFIC TAPE END POST ASSEMBLY
TWO HOLE WASHER PLATE
ONE HOLE WASHER PLATE

Fittings used with Page Traffic Tape



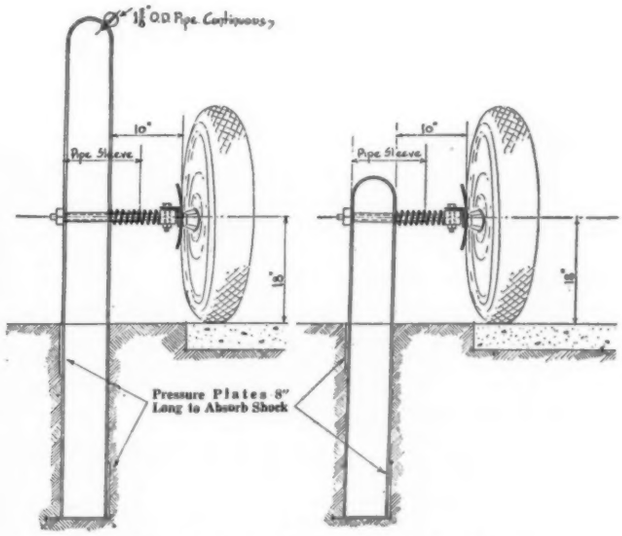
"Pittsburgh Safety" highway guard

Several firms make a steel band to be used as is the plank guard, placed at such an elevation that a wheel hub will strike it in the middle and slide along it. These differ among themselves chiefly in method of support, although different firms use different grades of steel. The distance between posts is pretty well standardized at 16 feet.

The "Duraguard" (Truscon Steel Co.) consists of a band of steel 12" wide, either galvanized or painted (generally white, for visibility), for 16 ft. post spacing (or other, if necessary); supported on posts by steel brackets of tubular form which serve as springs. Each length of band reaches from one bracket to the next. Successive lengths are joined by turning the ends at right-angles and bolting them together, thus giving no bolts or other projections on the face of the band.

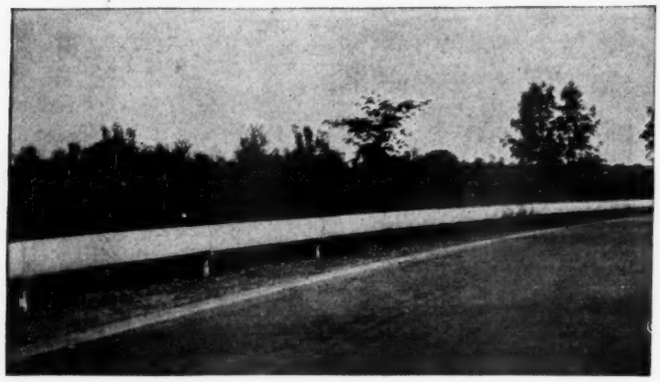
The "Tyton" (Toncan Culvert Mfrs. Ass'n.) uses a plate each edge of which is rolled into a curved flange on the back, finished width 11½", 11-guage, open-hearth, semi-spring steel, in lengths to give 16-foot post spacing, successive plates telescoping 6½" and bolted together and to offset post brackets, which are heavy leaf springs of carbon steel. The plates are so telescoped that the inner one follows the outer in the direction of travel, to minimize the resistance of the rail to a vehicle sliding along it.

The "Standco" guard (Standard Iron Works) uses a 10" x ⅛" steel plate, reinforced on the back with a 2½" x 2" steel angle, by which it is supported on the



Stand Co. Guard. Left, Style A support. Right, Style C support

TUTHILL GUARD RAIL



THE MOST EFFICIENT GUARD RAIL

Cross Section of Tuthill Guard

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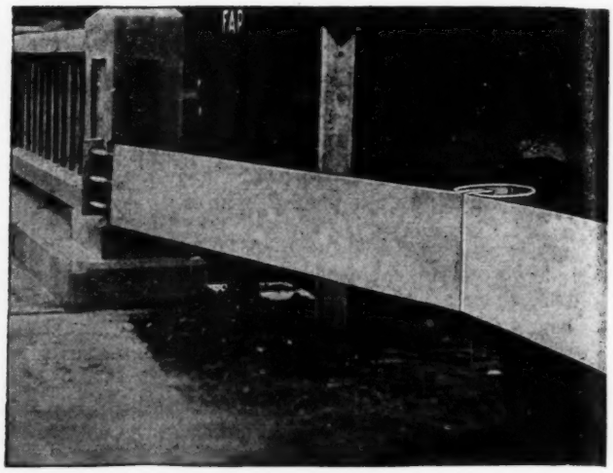


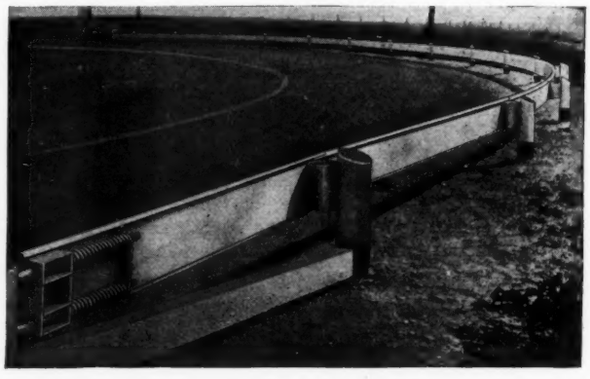
The Duraguard Highway Guard

post brackets; the posts being 6″ steel channels with rounded tops. The bracket consists of a pipe, pipe sleeve and spring, and at dangerous places the post extends 2′ above the bracket and carries at the top a 1⅝″ pipe rail, and a chain extends from the top to the bracket.

The "Tuthill" guard (Tuthill Spring Co.) consists of a steel plate, or rail, of 0.40 to 0.50 carbon steel, hot rolled, cold formed, 5/32″ x 12″ for posts spaced 10′ centers, 12 gauge for 16′ spacing, the steel plate being convexed. These are supported, their ends overlapping in the direction of traffic, by heavy spring steel brackets which are fastened at the base of the post and transmit the impact to this point, just above the ground, rather than near the top. In new construction, the posts are spaced so that the splices between rails come at the post bracket; but where posts are already in, they can be used and the rails spliced between posts. No anchorage of end posts is required.

The "Resiliflex" guard (National Traffic Guard Co.) consists of a band of 16-gauge spring steel 12″ wide, mounted on posts spaced 16′ centers (except the end panels, which are 8′) by means of a 3-leaf spring bracket of 12-gauge steel which holds it 6″ from the post. All metal parts are heavily hot-dip galvanized after all cutting has been done. Each end of the rail is turned back and spot-welded to form a loop which receives the pin at the bracket connection, forming a strong joint between rails.

All of these guards require posts for support. The posts are generally made of wood, sometimes of steel channels or tees. They should be set about four feet into the ground, and the earth solidly tamped around them.



End and intermediate connections of "Tyton" guard

Tuthill guard rail on approach to Sangamon river bridge.

It is well to creosote wooden posts up to a point about a foot above the ground, and the rest should be kept painted a light color. (The Bureau of Public Roads suggests aluminum paint.) Most manufacturers provide steel rods or cables, and anchors to be buried, for anchoring the end posts; but for the "Tyton" and "Duraguard" a brace is generally used between the top of the end post and the base of the next one (which is about 8′ away).

Generally it is desirable that the posts do not extend above the rail more than an inch or two, if at all.

The posts should be set truly vertical, aligned to a straight line or regular curve, and with their tops and the supported rail or cable exactly at a uniform height above the road grade. This is desirable for both effectiveness as a guard and for appearance. A guard rail can hardly be made a thing of beauty, but it *should* have a workman-like and substantial appearance.

The Ups and Downs of a Pump Station Roof

The pumping station and boiler room of the Newton, Mass., water works was built in 1876, of brick with slate roofs supported on wooden trusses. Twenty-eight years later the entire roof of the pumping station was raised 12 ft. to accommodate a vertical Barr steam pumping engine. In 1933 this engine was replaced with the much more compact as well as efficient steam turbine, and the roof was lowered back to its original position, since the great height of the engine room was undesirable when no longer necessary.

The former Barr pump had a station duty of 114,000,000 ft.lb. per 1,000 lb. of steam, while the three new De Laval steam turbine pump units developed duties of 188,013,000, 191,220,000 and 194,060,000 ft. lb. per 1,000 lb. of steam. This represents a saving in fuel of $4,600 a year.

Records of Rainfall Intensities in the U. S.

There are 206 Weather Bureau Stations in the United States which are equipped with automatic rain gauges to record the intensity of rainfall. D. L. Yarnell, of the Bureau of Agricultural Engineering, Department of Agriculture, Washington, D. C., has charted the rates of precipitations and their frequencies for these 206 stations, covering all sections of the United States.

Such information is necessary in intelligent designing of storm water drains, culvert waterways and farm drainage systems. The data prepared by Mr. Yarnell cover maximum rainfalls over periods of from 5 minutes to 400 minutes. The records range from 10 years up to 38 years in length.

Speaking before the American Geophysical Union, Mr. Yarnell quoted figures regarding Baltimore, as follows: "Once in about 5 years, for a 5-minute period, Baltimore and vicinity can expect a rainfall at the rate of 6.2 inches per hour, or 0.51 inch in 5 minutes. Once in 10 years, a rain can be expected which will have a rate of 6.82 inches per hour, or 1.14 inches in 10 minutes. For the period from 1896 to 1933, the maximum amount of rain that ever fell in Baltimore in a 5-minute period was 0.70 inch, and for a 15-minute period, 2.08 inches."

Revolving Filter Distributor in Maryland

The trickling filter at the sewage treatment plant of the Rosewood State Training School, Maryland, has been greatly overloaded for a nmber of years and greater capacity became necessary. However, due to its location it was found that the cost of enlarging it would be far greater than that of a new filter, and plans were made for a new circular trickling filter 80 ft. in diameter with a revolving distributor. Two bids were received for a revolving distributor and its siphon and contract for same awarded to the Dorr Company for $1,130. Bids for the filter structure and siphon chamber ranged from $4,347 to $7,791. The filter stone—approximately 1500 tons of trap rock ranging in size from 1 to 2½ inches—was purchased and placed by the school itself.

Cleaning Ditches and Improving Roads

In the Colorado mountains, rocks and stones which fall into the roadside ditches are used to surface the roads. A crew of six men, with a Cletrac tractor and a Day portable rock crusher, work along the roads, picking out the rock and stone from the ditches, and passing them through the crusher. The crushed stone is then spread on the road. The outfit shown here has a capacity of 50 tons of ¾-inch stone daily. The dual job of cleaning ditches and adding metal to the road is done at a cost of only $325 per mile.

Laying Concrete Pavements at Low Temperatures*

By D. S. MacBride
Manager, "Incor" Division, International Cement Corporation

THERE are good reasons why concrete pavement, when laid during cold weather, should be insulated against heat losses, particularly at the early periods. Protection should begin as soon as the concrete has been placed and continue until satisfactory strengths have been secured. The more efficient the insulation against heat losses, the more rapid will be the strength gain and the sooner will the concrete become immune to freezing and ready for service. Therefore winter-placed concrete is heated, high early strength cements are used and protection is provided against heat losses.

It is the temperature of the concrete and not that of the air which controls the setting and strength of the cement, and I have felt for some time that winter specifications should regulate the concrete temperatures only and may neglect air temperatures, since the latter need not influence final results but only the amount of protection required.

This was demonstrated by a state highway project near Cincinnati, Ohio (FAP No. D539C), built during the winter of 1932-33. Excavation, relocation of sub-structures and paving work went forward except in stormy weather. Sub-grade was prepared for a reasonable distance ahead and covered with straw. In the morning this straw was soaked with gasoline and burned, removing any light frost that may have formed in the sub-grade. Concrete was made with high early strength cement and heated aggregates, mixed and transported in the usual manner. The temperature of the concrete as laid on the sub-grade ranged from 60° to 75° and averaged 65°. To retain heat in the newly placed concrete, a covering of burlap and straw was applied as soon as possible after finishing. Concrete having a temperature of 60° when placed in an atmospheric temperature of 35°, retained that placing temperature the next morning even though the air temperature had dropped to 20° or lower during the night. Tests made by the Ohio Highway Department upon 6" x 6" beams and cores cut from the pavement slab gave the following average results:

Age Days	*Strength of Cores, Lb. per sq. in.*	*Modulus Rupture of Beams*
1	1716	235
2	2858	384
3	3760	534
7	4630	750

Six cores cut from this job within the past few days and tested at the age of one year averaged 5205 lb.

*Abstract of a discussion of the paper by H. F. Clemmer which appeared in *Public Works* for April.

Of a number of projects built last winter, all of which used high early strength cement, a few may be cited.

1. Two sections of U. S. route No. 1 through Philadelphia. The concrete, 1:1.8:3.75 mix using five gallons of water, was placed during December and January. Specifications required that the concrete when placed have a temperature of 60° which must not fall below 50° before a modulus of rupture of 500 lb. was secured. Burlap and straw covering promptly applied conserved both the artificial heat and the heat of hydration so that opening strengths were obtained within 48 hours despite an average air temperature of 45°.

2. Resurfacing of a concrete base from which a wood block top had been removed on Ohio Street, Indianapolis. Central mix concrete, made to a strength specification, was delivered on the job at temperatures ranging from 58° to 80°, average 67°, falling somewhat before covering was applied. On December 20th concrete temperatures, upon delivery, ranged from 72° to 80° while the air temperature was 42°. By the time covering was applied, the temperature of the concrete had dropped to 54°. The day following, air temperature at 9:30 A.M. was 32°, and 39° at 11:30 A.M., while the concrete placed twenty-four hours before was 42°. Temperature observations made on 6" x 12" cylinders, stored on the job in groups and covered with a heavy layer of straw, were found to be consistently lower than that of the corresponding pavement. On December 18, the air temperature was 38°; cylinders 40°, the pavement 64°. Compression tests on pre-moulded cylinders averaged as follows: one day 1260 lb.; two days 1460 lb.; three days 3820 lb.; seven days 4880 lb. This pavement was opened to traffic three days after concrete was placed.

3. Another Indiana project, an NRM job, built under State highway supervision on the Lafayette pike at the Indianapolis city line. A 1:2:3 mix concrete placed between December 3 and January 20. Specifications required a 550 lb. modulus of rupture before opening to traffic. Heated central mix concrete was placed at an average temperature of 75°, which fell 10° to 15° before covering with wet burlap and straw.

A typical series of temperature data are shown below.

The practice of *wetting down the straw covering* so that a frozen sheet would be formed over the concrete was followed on the latter part of this job. The under side of the ice was uniformly wet, the top dry and hard. Indications were that the higher concrete temperatures were observed under a straw covering, which had been frozen, then under dry straw. The data are too meager to allow a definite statement on this point. Opening strengths were secured consistently within three days.

4. A most spectacular demonstration of what high early strength cement, with full cold weather protection, can accomplish under winter conditions was provided by a project built in Butler County, Ohio, on State Highway Route 180 and U. S. Route 127. The paving consists of 7,000 lineal feet of 9"-7"-7"-9" concrete slab 30 ft, and 41 ft. wide. The contract was awarded on November 22; operations got under way three days later, and the first concrete was poured December 5, the last December 30. Freezing temperatures were encountered almost from the start, but concrete was placed continuously during the progress of the work, with the exception of one or two days when the sub-grade was not ready.

The usual cold weather precautions were taken on this job. Finished grading operations were confined to within 500 feet of the mixer, and the sub-grade was protected from the weather

Temperature Data on Indiana Project

		Concrete when	*Concrete when*	*24 Hours*		*48 Hours*		*72 Hours*
Date	*Air*	*Placed*	*Covered*	*Air*	*Under Cover*	*Air*	*Under Cover*	*Modulus Rupture*
12/10	37	73	——	19	46	21	44	——
12/13	33	75	62	28	59	62	68	522
1/2	28	84	64	27	50	27	48	——
1/6	36	85	——	24	45	29	50	550
1/7	40	70	72 hours later, air 27°, concrete 47°					

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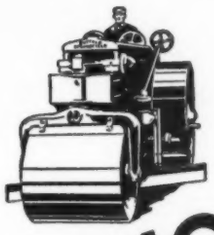
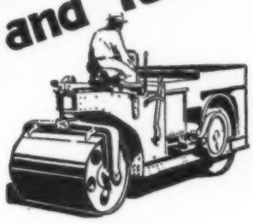


BUFFALO-SPRINGFIELD
Three Wheel and Tandem



Buffalo-Springfield's complete range of models in both three-wheel and tandem rollers permits the purchaser to select the proper machines for his work.

Full details will be furnished on request.

THE BUFFALO-SPRINGFIELD ROLLER CO.
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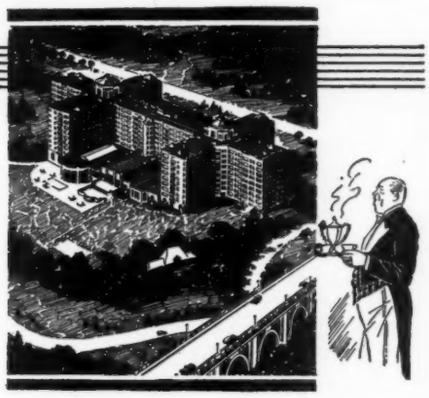

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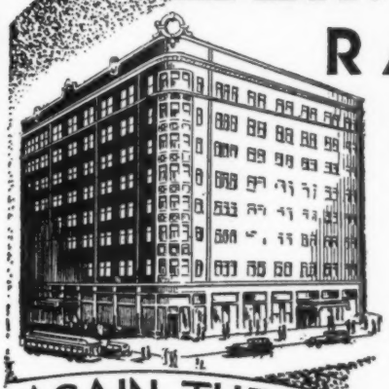

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Pages 28, 60 and 61 contain descriptions of many helpful booklets—Don't forget to look them over.

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with a covering of burlap and straw. Upon removing covering, any frosted subgrade was thawed out with hot water and steam and forms were similarly preheated preparatory to placing concrete slab.

Aggregates were heated by steam pipes at a batching plant, and water in a boiler at the mixer. Concrete was placed on the grade at an average temperature of 70°, and when finished was covered with wet burlap and straw to a depth of 10 inches, which was maintained until the required beam strength (600 lbs.) was obtained.

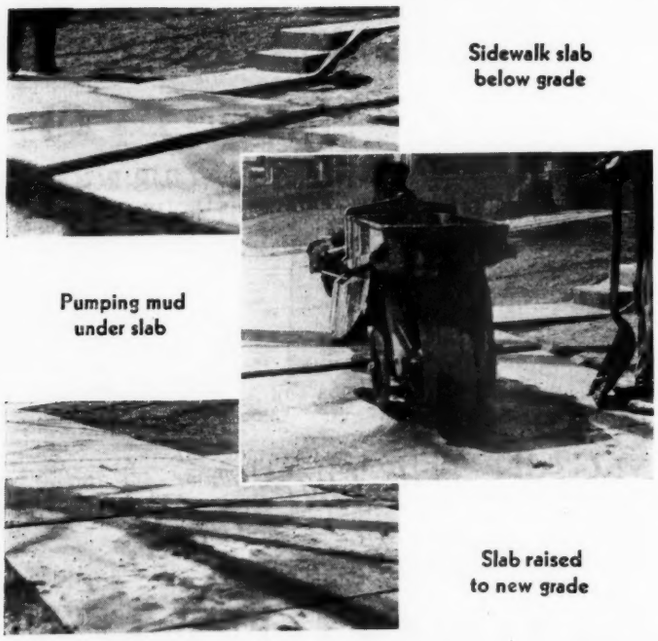
The 6" x 6" x 42" test beams were made from each day's pour, cured and protected with the pavement, and three breaks were taken from each beam, using job apparatus. Prior to December 23 the 36 beams tested developed the required flexural strength of 600 lbs. in 48 hours, in a number of instances the average being 72 hours. Average core test results were as follows:

Age	*Lbs. per Sq. Inch*	*No. of Tests*
24 Hours	1886	4
48 Hours	2341	4
72 Hours	3332	5
7 Days	4382	6
14 Days	5537	5

A particularly interesting test series was made on the concrete placed December 26. The first night the temperature dropped to 7° below zero. The next morning, surface readings taken under the covering indicated a concrete temperature of 44°, the air temperature at the time being 6° above zero. On the third night the air temperature dropped to 5° below zero. Cores cut from the pavement of that day's run gave, in 24 hours, 1509 lb.; 48 hours 2612 lb.; 72 hours 2610 lb.

Experience during the last two winters has demonstrated that the road building industry can continue to employ a substantial percentage of its workers throughout the winter, and that the added cost of winter concrete paving is much less than generally expected. Bidding data, plus field observation, indicate that an increment of 25c per square yard, in which is included the slightly higher price of high early strength cement, is ample to cover the cost of winter paving over summer construction.

MUD-JACK METHOD



Sidewalk Subgrade Reconstructed

This sidewalk slab was raised approximately 3½ inches to a new grade by the N. E. C. Mud-Jack in less than twenty minutes. New adjoining walk was laid at a higher level, making it necessary to correct grade of old walk. The Mud-Jack Method solves problems of this kind quickly and economically without the usual cost and time-consuming reconstruction activities.

Write for Mud-Jack Bulletin

KOEHRING COMPANY
Milwaukee Wisconsin

For Raising Concrete Curb, Gutter, Walks, Street

Pages 28, 60 and 61 contain descriptions of many helpful booklets—Don't forget to look them over.

Drying and Incineration of Sewage Sludge

By Alden E. Stilson, Assoc. M. Am. Soc. C. E.
Sanitary Engineer, Morse-Boulger Co.

In the first instalment of this article, in the May issue, Mr. Stilson dealt with drying of sludge preparatory to incineration. In this instalment he discusses incineration and the considerations important in designing incinerators. Some of the statements and conclusions given in this article are not agreed to by everyone, and next month we will publish discussion by others of the use of paper and other controversial points.

CAREFULLY prepared heat balances with large allowance for unknown losses indicate definitely that the successful drying of sludge can in many instances be carried out by utilizing the heat value of the sludge as the only fuel. A properly designed and operated incinerator will release this heat in the form of an odorless, colorless dead gas containing CO_2, H_2O, SO_2, N_2 and air. While it is possible to more or less closely duplicate results with all types of sludge in a standard design of *dryer*, similar success when using but one type of *incinerator* is not to be expected. The reason for this is apparent. In raw sludge all the volatile carbon is present and, as a result, the combustion rate is rapid and the heat released per unit weight of sludge tends to slag the ash. Unless ample air and time for complete combustion are given when burning raw sludge, explosions, smoke, slagging and attendant destruction of the incinerator and dryer are probable.

Activated sludge has lost some of its most combustible volatile carbon by "cold oxidation." However, such sludge demands as much care in its handling and burning as does the raw sludge. Digested sludge reacts much like hard coal containing an unusually large amount of ash. Sludge from chemical treatment plants is again a distinct fuel which has been found to be very difficult to consume. The ash content is high, large amounts of base metal fluxes have been added as the chemicals in the treatment. Using raw sludge as a standard of comparison, tests on chemically treated Dearborn sludge show that volatile carbon present is out of all proportion to fixed carbon.

At the present time paper is added to the incoming solids in certain types of treatment for various purposes. An examination of this custom from the standpoint of the dryer and incinerator only is quite interesting. Obviously, if 250 pounds of macerated or pulped paper is added to a ton of residual dry solids to be removed from a sewage, then for any given moisture content as received at the dryer, 11% more work must be done than would otherwise be necessary to similarly treat the 2000 pounds of offensive material. In a plant receiving sewage of the quality analyzed before and with a daily flow of 25 million gallons, this 11% means the removal of from 50 to 150 additional tons of water by the filter and dryer, depending upon the density of the sludge delivered to the filter. It is evident from this that the cost of collecting and preparing the paper for use is not the only cost connected with the use of paper if incineration of the sludge is the ultimate aim.

The value of paper as a fuel requires some exposition. On an *ash and moisture free basis* the approximate B.t.u. values of one pound of relative materials is interesting.

Paper*	±	7,500— 8,200 B.t.u.
Coarse bar screenings†	±	8,500— 9,500 B.t.u.
Fine screenings†	±	9,500—10,500 B.t.u.
Digested sludge	±	9,500—10,500 B.t.u.
Activated sludge	±	10,500—11,500 B.t.u.
Raw sludge	±	11,500—12,500 B.t.u.
Chemical sludge§	±	11,500—12,500 B.t.u.

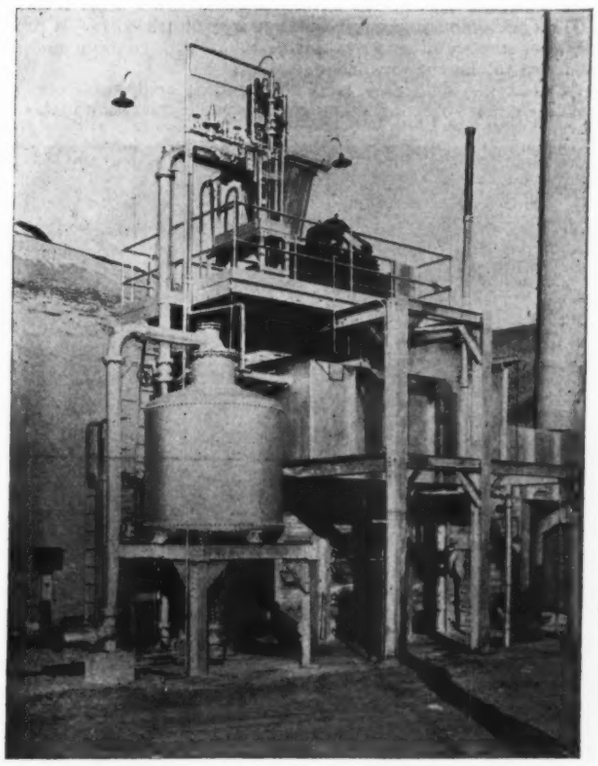
*According to Dulong's formula for fuel values of substances, which is (14,000 C + 62,000) (H—⅛O). Wood = 8200 B.t.u. Actual calorimeter tests of E. C. Miller when corrected for ash and moisture show paper to have + 7500 B.t.u. and chemically treated sludge + 12,500.
§Riley Stoker Corporation and E. C. Miller, Dearborn sludge.
†Milwaukee Sewerage Commission.

Assuming the best heat value of paper to be 8200 B.t.u. and that 4.4 pounds of dry paper in a 60% wet slurry have been added to 89 pounds of sludge having the following analysis, a heat balance may be struck off:

Analysis of Wet Sludge—100 Pounds—No Paper

H_2O	=	60 lbs.—60%
Ash	=	16 lbs.—16%
Combustible in Sludge	=	24 lbs.—24%
No paper		— —

Heat available=24 x 11,500	276,000
Heat to raise water to 212°=60 x (212°—60°)	9,120
Heat to raise water to steam @ 212°-60x971	58,260
Heat to raise steam to 1400° F.=60x.48x(1400-212)	34,214
Heat to raise ash to 1400° F.=16x.19x (1400-60)	4,075
Heat to raise combustible and 18 lbs. air per lb. of combustible from 60 to 1400—19x24x.24x1340.	146,650
Excess	23,681
	276,000



Hyperion, Los Angeles, sludge incineration plant. Burns 50 tons of 85% moisture screenings in 24 hours.

Analysis of Wet Sludge—100 Pounds—With Paper

H_2O .....60 lbs.—60%
Paper and ash ..... 4.4 lbs.— 4.4%=11% Dry Solids
Combustible and ash ....35.6 lbs.—35.6%=89% Dry Solids
Dry analysis of paper in mixture
Ash—10%— .44 lbs.
Combustible—90%—3.96 lbs.
Dry anaysis of sludge in mixture
Ash—40%—14.24 lbs.
Combustible—60%—21.36 lbs.

Heat Balance With Paper in 100 pounds of Sludge

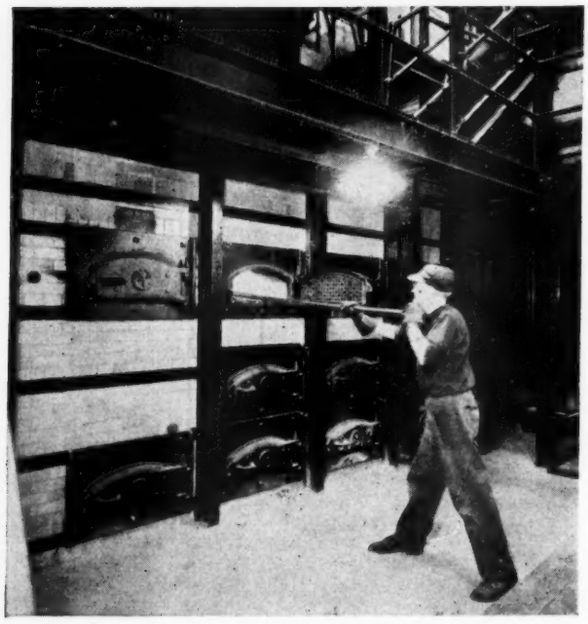
Heat to raise H_2O to 212	9,120
Heat to raise water to Steam	58,260
Heat to raise steam @ 212 to 1400	34,214
Heat to raise ash—14.68x19x1340	3,738
Heat to raise combustible and 18 lbs. air for combustion to 1400—25.32x.24x19x1340	154,796
Heat available in paper—3.96x8200	32,472
Heat available in sludge 21.36x11,500	245,640
Excess	17,984

Net results due to having 11% of paper in the dry solids in 100 lbs. of sludge is then an overall loss in heat value equal to 5697 B.t.u. In a ton of 60% wet sludge solids containing 11% of paper in the dry solids, the loss due to the adding of paper is equal to 5697 x 20=113940 B.t.u., or more than the useful heat value of a gallon of 147,000 B.t.u. oil, having a useful heat content at 1400° F. of about 92,700 B.t.u.

To summarize, the addition of paper costs money for collection, preparation and dehydration and it may cost extra money to burn it if there are not enough heat units in the sludge naturally to overcome the handicap. (Note that in both cases identical assumptions as to latent heat, specific heat, air for combustion and temperature were used. Likewise the heat value of paper used is maximum and the heat value of the sludge is minimum.)

In the design of incinerators for screenings, experience has shown the following information to be valuable.

1. A temperature range of from 1400° to 1600° F. is very satisfactory from a combustion standpoint in the firing chamber.
2. The ash slags readily at temperatures in excess of 1600°.
3. The combustible must be kept free of ash so far as possible or the residue from incineration will contain undue amounts of charcoal or carbon.
4. The ash is highly refractory and is acid, therefore it quickly attacks base metal and impedes the incineration rate.



South Yonkers incinerators. Burns 24 tons of 82% moisture screenings in 24 hours.

5. The ash is very light and floats readily even at low gas densities and velocities.
6. Burning the material without agitating or stoking is a waste of fuel.
7. Air in excess of the theoretical air required seems to be necessary. Probably the least it is safe to use is 18 pounds per pound of ash and moisture free combustible.

In the design of incinerators for sludge it is believed that the following suggestions will be valuable.

1. A temperature of 1600° to 1800° F in the firing chamber gives satisfactory results.
2. Dried sludge should be automatically and continuously fed in small quantities with safeguards provided to prevent back flood.
3. Continuous stoking and oil removal are beneficial.
4. Acid refractories of high density containing low quantities of native basic fluxes will best resist the conditions attendant upon sludge incineration.
5. A heat release of 16,000 B.T.U. per cubic foot per hour in the firing chamber is good practice.
6. The fired material should be subjected to radiant heat in order to burn out reluctantly combustible materials in the ash.
7. Primary and secondary air under definite control and quickly regulated is needed for best results.
8. Storage capacity and the time of storage for the dried sludge should be limited.
9. Combustion should be completed as near as possible to the point of introduction of the material.
10. An ample secondary combustion and settling chamber of large dimensions is essential.
11. Fly ash must be removed by positive means before discharge of waste gas to the chimney.
12. A detailed design of incinerator for one type of sludge is not necessarily a satisfactory design for another type of sludge.

Acknowledgement is due to many whose work and constructive criticisms have been of great value in preparing this article. Particular mention is made of Dr. A. Lloyd Taylor, Director of the Department of Chemistry of the Pease Laboratory. Dr. Willem Rudolfs has kindly prepared a very valuable criticism. It is hoped that others also present their views on the subject.

Sanitation in Sioux City

The annual report of Sioux City's Department of Sanitation for the year ending March 31st was presented to the mayor and council ten days later, on April 10th, by Superintendent W. H. Carrigg.

According to Mr. Carrigg, Sioux City is "the only city in the mid-west that gives this service (collection of rubbish) through its Sanitation Department. In all other cities, collections of ashes and rubbish are paid for privately by individual householders and this means it is much more costly."

During the year the department collected 8,611.5 tons of garbage (145.5 tons less than the year before) and 18,823 tons of ashes and rubbish (1,428 tons less than the year before). The former decrease was due to the fact that more families burned their garbage than formerly. The latter decrease is accounted for by the shortage of funds in the department which necessitated the removal of ashes by individual householders for a period of about two weeks.

The departmental expenses totaled $45,643, of which $43,913 was pay roll. The car mileage was 15,077; payments for gasoline and oil $162.27, auto expenses, $538.89; repairs $10.60.

Although the tonnage collected was 5.7% less than the previous year, the cost per ton was slightly less—$1.663 in 1933 and $1.69 in 1932.

The refuse is hauled to dumps. A number of these were filled with dirt by CWA workers last year, necessitating longer hauls to more distant dumps this year.

American Water Works Association

The 54th Annual Convention of the American Water Works Association will be held in New York City, June 4 to 8, at the Commodore Hotel. There will be three principal sessions on purification, two on finance and accounting, two on plant management and operation, and five general sessions.

Water Purification

MONDAY, 2 P. M., Special Conference, George D. Norcom, chairman: Report of Committee on specifications and methods of tests for water purification chemicals, M. M. Braidech, committee chairman. Discussion by A. M. Buswell, Carl J. Lauter, W. M. Wallace, L. I. Birdsall and August G. Nolte.

TUESDAY, 2 P. M., Determination of Odors and Tastes in Water by the Air Dilution Method, by Gordon M. Fair, discussion by M. Warren Cowles. 2:30, Occurrence and Control of Iron Bacteria in Water Supplies, by Kenneth W. Brown, Calif. Water Service Co., discussion by Dr. Frank E. Hale. 3:00, The Spectographic Determination of Minor Chemical Constituents in Various Water Supplies in the U. S., by M. M. Braidech, discussion by Sheppard T. Powell. 3:30, Report of Committee of Testing Zeolites, by Charles P. Hoover, discussion by Jack J. Hinman, Jr. 4:00, Report of Committee on Filtering Materials, by Frank W. Herring, discussion by G. Gale Dixon.

Water Purification Division Dinner, 6:45 P. M.

WEDNESDAY, Symposium on Chlorination: 9:30 A. M.: Equipment for the Application and Control of Chlorination in Small Water Supplies, by Charles R. Cox, 9:45, Handling Chlorine to Avoid Trouble, by L. L. Hedgepeth, discussion by Charles E. Trowbridge. 10:15, Review of the Status of the Ammonia-Chlorine Process, by Marsden C. Smith. 10:30, A Study of the Efficiency of the Ammonia-Chlorine Process, by Atmore E. Griffin, discussion by Harry E. Jordan. 11:00, Interference of Manganese with the Orthotolidine Test, by A. M. Buswell. 11:15, Interference of Forms of Nitrogen with the Orthotolidine Test, by Roberts Hulbert, discussion by C. A. Holmquist. 11:45, Review of the Entire Discussion, by Lynn Enslow.

Plant Management and Operation

MONDAY, 2 P. M., general session, with Superintendents' Round Table Discussion. Carl A. Hechmer, chairman.

WEDNESDAY, 9:30 A. M., Outstanding Factors in Underground Water Surveys, by Fred B. Nelson, discussion by Justus B. Eddy. 10:10, Thawing Frozen Service Pipes, by Reeves J. Newsom, discussion by J. Arthur Jensen. 10:50, Superintendents' Round Table Discussion.

Finance and Accounting

TUESDAY, 9:30 A. M., Changes in Federal Tax Laws Affecting Water Companies, by L. D. Blum. 10:00, Taxation as Applied to Municipally Owned Water Works, by A. C. Kamplain, discussion by E. J. Fricker. 10:40, A Property Record for Investment in Fixed Capital, by F. C. Hamilton, discussion by C. J. Alfke. 11:20, Work Incentives, by Hal Smith. 12 Noon, Mechanical Aids to Scientific Office Management, by W. P. Adams.

WEDNESDAY, 2 P. M., Financial History of Water Department of New York City, by Joseph Goodman, discussion by John Murdoch. 2:40, Uniform Classification of Accounts Suitable for Municipal and Private Plants, by E. V. Williamson, discussion by F. W. Schulz. 3:20, Federal Securities Act in Relation to the Financing of Water Companies, by Berne H. Evans. 3:50, Effective Publicity as a Means of Eliminating Water Waste, by H. L. Meites.

General Sessions

TUESDAY, 9:30 A. M., Features of New York City's Water Program, by W. W. Brush, discussion by Thaddeus Merriman. 10:15, Pipe Corrosion Experiments, Catskill Supply, by Frank E. Hale. 11:00, Water Works and the PWA Outlook, by W. T. Chevalier, discussion by Abel Wolman.

2 P. M., Direct Purchase of Materials and Equipment vs. Purchase Through Contractors, discussion by Paul Hansen and L. R. Howson. 2:40, New Questions of Law and Policy in Making Rates, W. L. Ransom. 3:20, Recent Tendencies in Relation to Valuation of Water Rights, by R. E. Horton. 4 P. M., Tests of Friction Loss in Distribution Piping, by Burt B. Hodgman, discussion by E. K. Wilson.

WEDNESDAY, 2 P. M., Coagulation with Iron Compounds, by Dr. A. P. Black, discussion by Robert Sawyer. 2:30, Significant Features of the Chicago Amebic Dysentery Outbreak: *Engineering*, by Joel Connelly, *Epidemiology*, by Arthur E. Gorman, with discussion by Abel Wolman and Thorndike Saville. 4:00, Discussion on Taste and Odor Control, John R. Baylis, Alfred Eckert, George R. Spalding, and Norman J. Howard.

THURSDAY, 9:30 A. M., Milwaukee's Water Purification Problem, by J. P. Schwada, discussion by John Baylis. 10:15, Automatic Pumping Equipment and Telephonic Supervision at Baltimore, by Leon Small. 10:40, Telemetering—The Electrical Transmission of Gage and Meter Readings, by P. S. Wilson. Discussion of these two papers by J. W. Cutler, D. J. Purdie, and representatives of the General Electric Co.

Pennsylvania Sewage Works Association

The 11th annual conference of this association will be held at State College, Pa., June 27-29. It will follow, we presume, the meeting of the Pennsylvania Water Works Association, which is usually held at the same place and during the same week.

Dr. Willem Rudolfs will open the Wednesday afternoon session with "Some of the Newer Developments Abroad." Following the address of welcome by Prof. F. G. Hechler on Thursday morning, Prof. Gordon Fair will present a paper on "The Trickling Filter Fly; Its Habits and Control," which will be discussed by Harry J. Krum, city chemist of Allentown. Albert L. Center of Baltimore will then speak on "Elutriation and Filtration of Sewage Sludges," which subject will be discussed by C. E. Keefer, Principal Assistant Engineer of the Baltimore Bureau of Sewers.

In the afternoon, Frank Woodbury Jones of Cleveland will present a paper on "Comparison of Vacuum Filters and Open and Glass Covered Sludge Drying Beds" and Wellington Donaldson of New York will discuss it. Later the Sewage Treatment Plant operators will hold a symposium, with H. N. Herr, chief civil engineer of Hershey Estates, Hershey, describing the "Hershey Sewage Treatment Works and Its Operation." This will be discussed by I. M. Glace of the Pennsylvania Dep't of Health, while R. C. Gorman, also of the Department will discuss the next paper, which will be presented by C. A. Eckbert, Borough Manager, Hanover, on "The Operation of the Hanover Sewage Treatment Plant and Its Ejector Stations."

The annual dinner will be held Thursday evening, with H. E. Moses presiding. Friday, W. L. Stevenson, chief engineer of the Pennsylvania Department of Health, will read a paper on "Plant Operation," which will be discussed by H. M. Beaumont of the Bureau of Engineering of Philadelphia; "Notes on Sedimentation" will be presented by L. V. Carpenter of the University of West Virginia and discussed by F. B. Foote of Morris Knowles, Inc., Pittsburgh; C. H. Young, of the State Department of Health, will speak on "Sludge Digestion at Meadville," and this will be discussed by J. R. Hoffert, also of the Department.

A full program, and apparently up to its usual high degree of excellence.

New York State Sewage Works Assn.

The spring meeting of the NYSSA will be held at Jamestown, N. Y., on June 15 and 16. The preliminary program shows interesting papers by Henry Ryon on "Sewage Treatment Plant for the Harlem State Hospital;" by J. H. Brendlin on "Chemical Treatment of Sewage Sludge;" by A. E. Stilson "Incineration of Sewage Solids;" by Earl Devendorf on "Federal Aid"; and by C. E. Keefer on "Filtration of Electriated Sludge." The question box, sunrise breakfast, and many other features.

[Short Talks with Sewage Plant Designers]

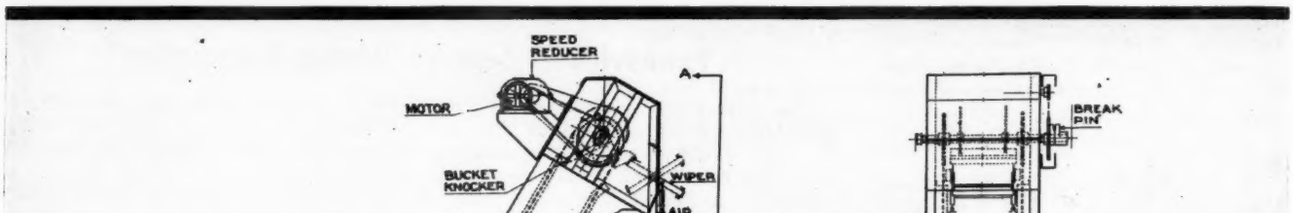
How much GRIT have you?

THE right kind of grit is a mighty good thing to have these days. But mineral grit and other detritus may be awfully troublesome—say in sedimentation tanks, and especially in Imhoff tanks. And if it settles in an inverted siphon or flat grade in a sewer system, a lot of money and trouble may be required periodically for removing it.

Ask plant operators how they like to find a lot of sand packed around the sludge pipe in the bottom of a sludge hopper; or settled onto the air-diffuser plates in the bottom of an activated sludge tank; or in the sludge delivered into the vat of a vacuum filter; or anywhere in the plant, in fact—even in the grit chambers themselves.

For it is heavy stuff to handle, and unless removed frequently is apt to pack down solid, while the organic matter in it putrefies. And a grit chamber or pit is pretty sure to do one of two things—probably both; fail to hold back all the detritus, or retain with it considerable organic matter.

A Link-Belt type "C" combined screen and grit chamber will catch the grit, and will remove it before it compacts, or the organic matter putrefies. And it does this mechanically and automatically. Moreover "it works while you sleep," and many of the storms that flush grit deposits into the sewer, or into the plant, occur at night.



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News of the Engineering Field

Dorr-Oliver Corporation Being Dissolved:

After affiliation for three years, it has been agreed to dissolve the Dorr-Oliver Corporation, and that The Dorr Company, Inc., and Oliver United Filters Inc., thereafter will operate independently of each other.

Oliver United will, however, undertake the further adaptation and marketing of the Dorrco Filter in the United States and in certain other countries; and Oliver United products, including filters, will be handled in European territories by the foreign representatives of the Dorr Company.

The separation of the two companies has been brought about on an entirely friendly basis, and the many personal friendships which have been formed among members of the two organizations during the past three years will be continued.

Austin Mfg. and Western Wheeled Scraper Combine:

Of interest to all users of road building, earth moving and construction equipment is the announcement of a business consolidation involving the Western Wheeled Scraper Company of Aurora, Illinois, and Austin Manufacturing Company of Chicago and Harvey, Illinois. The consolidated company will operate under the name of Western-Austin Manufacturing Company.

Western Wheeled Scraper Company originated the wheeled scraper more than fifty years ago and since then has been a vital factor in the earth moving industry. Later, closely allied interests acquired the Austin Manufacturing Company, established about the same time for similar lines, and in order to market the road machinery products of the two factories, The Austin-Western Road Machinery Co. was formed. In addition to this, the Western Wheeled Scraper Company has maintained its own sales organization. Gradually, but inevitably, this has resulted in a duplication of service which makes consolidation desirable. The consolidation will become effective by July 1, 1934, and the general office of the consolidated corporation will be at Aurora. The Austin-Western Road Machinery Co. will continue to handle the sales of the manufacturing company.

Personal News

William W. Brush, Chief Engineer of the New York City Board of Water Supply since 1927 and one of the leading water works engineers of the world, has resigned. Mr. Brush has served the city of New York Board of Water Supply for nearly forty years.

Charles De Leuw & Co., Engineers, have moved their office to the Civic Opera Bldg. 20 N. Wacker Drive, Chicago, Ill.

Morse-Boulger Destructor Co. has moved to new offices at 202 East 44th St., New York, N. Y.

The National Recovery Administrator has approved the method of selection, constituting recognition, of a Code Authority for the Shovel, Crane and Dragline Industry. The members are: W. M. Bager, chairman, Bucyrus Company, South Milwaukee, Wis.; T. H. Watters, The Marion Steam Shovel Co., Marion, Ohio; D. B. Patterson, Harnischfeger Corp., Milwaukee, Wis.; W. S. Ramsay, Bay City Shovels Inc., Bay City, Mich.; C. A. Owens, The Osgood Co. & General Excavator Co., Marion, Ohio; H. C. Brown, The Industrial Brownhoist Corp., Bay City, Mich.; C. B. Smythe, The Thew Shovel Co., Lorain, Lorain, Ohio.

Lorenzo D. Cornish, former chief engineer of the Illinois Waterways, died in Chicago. He was 57 years old, a graduate of Syracuse University (1902), and served on the Panama Canal, in China, with the U. S. Engineer Department and the State of Illinois. He served overseas as a Major of Engineers. Because of ill-health he retired from active service about a year ago.

Guy H. Newton has been appointed Works Manager of the Graver Tank & Mfg. Corp., Chicago, Ill.

Stephens-Adamson Mfg. Co., conveyor manufacturers of Aurora, Illinois, have reopened sales-engineering offices at Pittsburgh and Huntington, West Va. The Pittsburgh office is located at 1206 Gulf Bldg. and is under the supervision of Harry W. Banbury, who has long been associated with the firm as purchasing agent and special sales engineer.

The Huntington sales and engineering will be handled by D. W. Allen, a tipple and conveyor expert with years of experience in the West Virginia district.

Bucyrus-Erie Co. announces the consolidation of the New York and Boston offices under the direction of J. C. Alexander, with headquarters at 270 Broadway, New York City. An office will be maintained at 240 North Beacon St., Brighton District, Boston. F. Leslie Jones and R. W. Conant have been appointed assistant managers, with headquarters in New York.

C. E. Funk, eastern manager of the Construction Equipment Co., Waterloo, Ia., died May 24 while on a visit to Ridgewood, N. J. Mr. Funk lived in Philadelphia.

Recent Catalogs

Truck Bodies:

A series of Bulletins describing a full line of truck bodies of many types and all sizes has been issued by Hercules Products Co., Evansville, Ind.

"Pop-Up" Shows Half-Yard Convertible Shovel:

Specifications, working range data and machinery illustrations of the new Bay City heavy duty half-yard shovel Model 38, are given in a new folder just issued by that company. This folder is of particular interest because it is the first "pop-up" we have seen in the highway field. Worth looking at, aside from the data it contains.

Vibrating Feeders and Conveyors:

An 8-page and a 4-page folder by Jeffrey Mfg. Co., Columbus, O., describing vibrating feeding and conveying equipment.

Highway Finisher:

The new type "D" Jaeger-Lakewood automatic finisher is described in Bulletin 47-G, issued by Jaeger Machine Co., Columbus, O.

Caterpillar Elevating Grader:

A folder issued by the Caterpillar Tractor Co., Peoria, Ill., describes the power take-off driven elevator grader, which, used behind the more powerful tractors, has a tremendous dirt-moving capacity.

Highway Construction Equipment:

Three new pieces of literature, describing the newly designed Western "primary breaker for rock crushing, the new Austin dual and single drive motor graders, and small earth moving tools—the drag, wheeled and fresno scrapers—have been issued by Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago, Ill.

Material Prices

(May 23, 1934)

Prices on cast iron pipe, net per ton, Class B, 6-inch and larger, AWWA specifications*

Boston	$45.50	Baltimore	$43.50
New York	42.90	Atlanta	40.00
Chicago	44.00	Birmingham	36.00
Minneapolis	46.50	Kansas City	46.15

Burlington, N. J., $40.00; extra price for 4-inch, $3.00 per ton; extra for class A, $3.00 per ton.

**Information, courtesy U. S. Pipe & Foundry Co.*

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*New Billet Reinforcing Bars*
New York	3.42c	—
Boston	3.42	—
St. Louis	3.49	—
Cincinnati	3.45	3.10
Pittsburgh	3.20	3.00
Chicago	3.10	—
Philadelphia	3.00	2.955
Cleveland	3.36	2.10
San Francisco	3.55	3.50

Warehouse Prices on American Pig Lead

New York	4.75 to 5.75
Cleveland	5.00 to 5.25

Readers' Service Department

(Continued from page 28)

To help you in your work, any of this **INDUSTRIAL LITERATURE** will be sent **FREE** upon request.

It is a good practice to check this list regularly because descriptions of new bulletins are always being added. ★

Construction Materials and Equipment

Asphalt Heaters

9. Illustrated manual No. 11 describes "Hotstuf," the master oil burning heater. The only heater with patented elevated melting chamber for Asphalt, Tar and all bitumens used in road and street construction and maintenance, roofing, water proofing, pipe coating, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Protective Coating

118. KRODEPROOF, the ideal protective coating for all structural surfaces subject to corrosion or contact with **water** is described in an 8-page bulletin recently issued by Lewis Asphalt Engineering Co., 30 Church St., New York, N. Y.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subjects suggested by title.

31. "Curing Concrete Roads with Solvay Calcium Chloride," 30 page booklet. Comprehensive. Contains tables, illustrations, suggestions for testing devices. Covers the subject in considerable detail. Solvay Sales Corp., 61 Broadway, N. Y. C.

35. "A report on Current Practice of using Calcium Chloride for curing Concrete Pavements, Bridges, Culverts and Concrete Products." It includes reports from the Highway Research Board, the Bureau of Public Roads and State Highway Departments. Columbia Products Co., Barberton, Ohio.

Concrete Mixer

44. Concrete Mixers, both Tilting and Non-Tilting types, from 3½s to 84s size, The Jaeger Machine Company, Columbus, Ohio.

Crushers

57. Up-to-date information on Stone Crushers, Stone Spreaders, Unloaders, Drags and other contractors' equipment from the Galion Iron Works & Mfg. Co., E. Jeffry Mfg. Co., Columbus, Ohio.

Culverts

60. "In diameters up to 10 feet and larger . . ." just issued by the Armco Culvert Mfrs. Assn., tells a good deal about drainage problems and their solution. 32 pages about drainage and multi-plate culverts.

Explosives

74. "Use of Explosives for Settling Highway Fills. A new booklet which fully explains by diagrams and charts the three methods developed after many tests by the Du Pont engineers, which singly or in combination will quickly and efficiently do your job. Just issued by E. I. Du Pont de Nemours & Co., Inc., Explosives Dept., Wilmington, Del.

Graders

76. Latest information about Galion Motor Patrol Graders, Road Maintainers and Leaning Wheel Graders with hydraulic control is contained in a new series of illustrated catalogs, Nos. 125, 130, 135 just issued by the Galion Iron Works & Mfg. Co., care of The Jeffrey Mfg. Co., Columbus, Ohio.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Joint Filler and Line Marker

88. Bulletin No. G-9 issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio, describes and illustrates their new No. 91 Joint Filler which is used to fill horizontal and center joints with hot asphalt. It can be equipped to apply an asphaltic center line as it fills the center joint. This bulletin also describes the Littleford Traffic Line Marker.

Joint Filling Pot

89. A supplement to Bulletin No. E-5 has been issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio, describing their cone-shaped crack filling pot No. 86-B. The chief feature of this pot is that it is springless—there is no mechanism to get out of order. It is used to fill cracks and joints in concrete pavements and interstices in brick or granite block pavements.

Loaders and Unloaders

97. Portable Loaders and Unloaders. Folders: Nos. 1248, 1298 and 1074 cover Belt Conveyors with channel iron and truss types of framework; No. 1076, Portable Bucket elevators for different classes of work; and No. 1256, the "Grizzly" Crawler Loader for heavy work and large capacities. Link-Belt Company, Philadelphia.

100. Materials Handling and Positive Power Transmission Equipment, giving technical data, list prices and illustrations of this machinery. Link-Belt Co., Chicago, Ill. General Catalog No. 500.

Motor Trucks

105. Full information about their complete line of motor trucks, all powered by six-cylinder "truck-built" engines of uniform valve-in-head design, will be sent promptly. General Motors Truck Co., Pontiac, Mich.

106. "Trucks for Public Utilities," is a new illustrated booklet just issued by the International Harvester Co., 606 So. Michigan Ave., Chicago. Covers uses, types, special equipment, bodies and specifications. Sent free on request.

Paving Materials

108. "Emulsified Asphalts" is a 56-page manual covering Penetration Type Construction, Road and Plant Mixes Pavements, Surface Tratments and Maintenance Methods. Includes 58 illustrations. Sent free by Headley Asphalt Division, Sinclair Refining Co., P. O. Box 70, Marcus Hook, Penna.

226. "Asphalt Surfacing Materials for Low-Cost Roads" is a handy, 28-page booklet illustrating the many types of road surfaces which can be constructed with Texaco asphalt materials. Well illustrated and contains tables of amounts of stone, sand and asphalt required. Sent promptly by the Texas Company, 135 East 42nd St., New York, N. Y.

109. A 36-page booklet with 66 illustrations has just been issued by the Barrett Co., giving full information regarding the making, laying and maintaining of "Tarvia-lithic," the ready-to-lay pavement.

111. "Tarvia Double Seal Pavements." Shows, step by step, the construction of a Tarvia pavement. 24 pages. The Barrett Company, 40 Rector Street, New York.

112. Complete directions for surface Cut Back Asphalt are contained in a 36 treatment and bituminous surfacing with page data book. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

Road Machinery

126. A new general reference catalog No. 1320 covering their entire line of equipment for every approved method of construction and maintenance has just been issued by Austin-Western Road Machinery Co., 400 No. Michigan Ave. No. A-5, Chicago, Ill. Profusely illustrated with action pictures showing each type of machine out on the job.

127. "Road Machinery Illustrated." New illustrated bulletins on the motor rollers, three-wheel and tandem rollers, motor graders powered by Caterpillar, Twin City, Cletrac. McCormick-Deering and Fordson tractors, and straight and leaning wheel graders. Galion Iron Works & Mfg. Co., Galion, O.

6-34

★**Paste on post card and mail.**

Readers Service Dept.
PUBLIC WORKS
310 East 45th ST., NEW YORK

Please send me without obligation the following booklets listed in your INDUSTRIAL

LITERATURE SECTION .....
(INDICATE BY NUMBERS)

.....

Name .....

Occupation .....

Street .....

City ..... State .....

See additional descriptions on page 28

Rollers

132. A 32-page book in four colors featuring a complete line of road rollers. 8¾ x 11, leatherette cover, numerous action pictures. Buffalo-Springfield Roller Co. of Springfield, Ohio.

133. 20-page pocket size booklet showing all types of Buffalo-Springfield motor rollers and scarifiers and their uses.

134. "The Chief," a six cylinder roller of advanced design and construction is fully described in an illustrated catalog just issued by the Gallon Iron Works & Mfg. Co., care of The Jeffrey Mfg. Co., Columbus, Ohio. Gives complete details of the very latest development by this company.

Sand and Gravel Washing Plants

140. Seventy-page catalog giving complete information regarding Sand and Gravel Washing Plants, stationary and portable. Those interested in such equipment should have a copy. Link-Belt Co., Chicago, Ill.

Shovels, Cranes and Excavators

145. The Austin Badger, a new, fully convertible ¾ yard crawler shovel, made by The Austin-Western Road Machinery Co., 400 North Michigan Ave., No. A5, Chicago, is fully described and illustrated in their Bulletin No. 1236.

146. Link-Belt Co., Chicago, Ill., has issued Book No. 1095, which describes and illustrates their complete line of Gasoline, Electric, or Diesel operated shovels, cranes and draglines. 910 S. Mich. Ave.

Tires, Truck and Tractor

165. Speed and economy in use of solid, cushion and pneumatic tires and tubes for trucks, cars, tractors, graders and other road machinery. Government Sales Department of the Goodyear Tire & Rubber Company, Inc.. Akron, Ohio.

Street and Paving Construction

Asphalt Mixing Plants

204. A new illustrated bulletin No. M234 describing their asphalt mixers for bituminous paving mixtures of all kinds has just been issued by Hetherington & Berner, Inc., 701 Kentucky Ave., Indianapolis, Ind. Covers both steam-jacketed, steam operated; and hand operated types. Sent on request.

Distributors

206. Kinney distributors of from 600 to 1,700 gallon tank capacity with heating system and the Kinney jacketed pump having a capacity of over 400 gallons per minute are described in a new catalog just published by the Kinney Mfg. Co., 3533 Washington St., Boston, Mass.

Dust Control

209. "3000 men put back to work in a single county." A new folder just issued by the Solvay Sales Corp., 61 Broadway, New York City, outlining a road program which is a relief program. Sent promptly on request.

210. "How to Maintain Roads," by the Dow Chemical Company, Midland, Michigan, is a manual dealing thoroughly with dust control, road building and maintenance.

211. "Principles of Road Soil Stabilization," a new booklet just issued by The Columbia Alkali Corporation, Barberton, Ohio. Gives a clear, concise picture of what road soil stabilization is and how it can be accomplished.

212. "Wyandotte Calcium Chloride Prevents Dust the Natural Way,"—a publication, fully illustrated, treating on Dust Control, economical road maintenance and methods of application, issued by the Michigan Alkali Company, 10 E. 40th St., New York City.

Dust Laying

213. Full information regarding the use of Solvay Calcium Chloride for effec- Calcium Chloride, a Natural Dust Layer," 24 pages, 5½x8, covers application, econtively laying dust. The booklet, "Solvay omies, etc. Sent without cost. Solvay Sales Corporation, New York.

Emulsion Sprayers

214. A complete line of emulsion sprayers is described in Bulletin No. G-5 recently issued by Littleford Bros., 452 E. Pearl St., Cincinnati, Ohio. Littleford Emulsion Sprayers will spray any type of asphalt emulsion used for penetration patch work or curing concrete. They are also used to spray silicate of soda and weed exterminators.

Guard Rail

26. Accurate cost comparisons in erection of thousands of feet of Tuthill guard rail compared with other types. Everyone contemplating the construction of guard rail should have this data. Tuthill Spring Co., 760 Polk St., Chicago, Ill.

Mixed-in-Place

218. "Mixed-in-Place" bituminous road construction. The construction of low-cost, dustless, mudless roads in a new and better way with the Parsons "Turbo-Mixer." Full details sent promptly by The Parsons Company, Newton, Iowa.

Surface Heaters

220. The "Hotstuf" three in one, combination Tool, Asphalt and Surface heater is described and its use illustrated in Bulletin 16. Mohawk Asphalt Heater Co., 56 Weaver St., Schenectady, N. Y.

Sweepers

223. A universal sweeper, especially adapted for the sweeping requirements on re-tread, black top and oil treated paving contracts, is described and illustrated in a new circular just issued by The Frank G. Hough Co., 919 No. Michigan Ave., Chicago, Ill. This sweeper is for use with team, truck or tractor; has reversible brush and independent engine drive.

Noiseless Manhole Covers

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

Brick, Paving

230. Full information and data regarding the use of vitrified brick as a paving material, cost, method of laying, life, etc. National Paving Brick Manufacturers' Association, National Press Building, Washington, D. C.

Concrete Curing

235. "How to Cure Concrete," is a manual of instruction on the curing of concrete pavements. 47 pages. The Dow Chemical Company, Midland, Mich.

Gutters

240. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome. Covers design, construction and results. Well illustrated. Just issued by the National Paving Brick Ass'n, National Press Building, Washington, D. C.

Jacking Culverts

260. No interruption to traffic, and substantial savings in construction costs are the main advantages secured by using the Armco jacking method to install conduits, drainage openings, and passageways under streets, highways and railroads. "The Armco Jacking Method," describing this modern means of construction and its many applications, will be sent upon request, by Armco Culvert Mfrs. Association, Middletown, Ohio. Ask for Catalog No. 7.

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For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Timber Manual:

The Forest Products Laboratory has published "A Guide to the Grading of Structural Timbers and the Determination of Working Stresses" issued as Miscellaneous Publication No. 185 of the U. S. Department of Agriculture. This circular describes the factors that affect the strength of timbers, shows how to define and limit them in grade specifications, and how to determine working stresses for any given grade. Copies of the Guide may be obtained at 5 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Results of Municipal Lighting Plants:

Under this title the Burns & McDonnell Engineering Company has issued the 1934 edition of an electric rate book showing what 363 representative cities pay for electricity. The past year has brought about many drastic rate changes, both in private and municipal plants. The new book covers nearly twice the cities of last year's edition.

The little volume is a unique and informative record of the rates, earnings, operating expenses, net profits, kilowatt-hour production and other information pertaining to the use and cost of electricity. Its 160 pages are profusely interspersed with graphs and charts showing the downward trend in the cost of electricity and the upward trend in the consumption and wider use of electricity. Officials, operators and managers will find it valuable. It may be procured at a cost of $1.00 by addressing the publishers, Burns & McDonnell Engineering Company, 107 West Linwood Boulevard, Kansas City, Missouri.

Hookworm:

An article, on this subject, with especial reference to Kentucky conditions, was published in the April Bulletin of the State Board of Health, Louisville, Ky. The hookworm itself is described, the conditions under which found and methods of transmission enumerated, and considerable information on control is given. The work of the sanitarian is stressed as of the greatest importance.

Soil Stabilization—Construction and Testing:

Two new booklets on this subject: No. 1. Materials and methods for construction and maintenance of low cost stabilized roads; No. 3. Methods and equipment for sampling and testing soils and calculating stabilized soil mixtures. The first has 20 pp. the latter 24 pp. Both are well illustrated, and contain explicit directions for procedure. No. 1 contains brief specifications for construction. No. 3 makes clear the procedure in sampling and calculating mixtures. We believe every man interested in low cost road construction and maintenance should have these. Sent on request to the Editor of PUBLIC WORKS, or to George H. Kimber, Solvay Sales Corp., 61 Broadway, N. Y.

Vibration in Concrete Placing:

A loose leaf, paper bound, booklet put out by the Electric Tamper and Equipment Co., Ludington, Mich., tells about vibrocast concrete and describes in detail equipment for placement. Worthwhile to engineers who are interested in concreting. For a copy of the booklet write M. S. Westlund in care of the above office, or the Editor of PUBLIC WORKS.

Savings by Using Boiler Meters:

This bulletin includes actual operating data showing the nature and amount of savings effected in over 20 typical installations of Bailey Boiler Meters which cover a wide range of fuels, methods of firing, types and sizes of boilers. A tabulation of plant data listing major equipment, and a summary of savings showing investment, depreciation, interest, maintenance, net annual saving and net annual return on the investment are included for each of the various examples cited. The bulletin contains handy indexes of the type size, method of firing of boilers, and methods by which savings are effected. Under each subject is listed the page numbers on which examples may be found. Write Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, O., for a copy.

Water Supply and Waste Disposal:

A rotogravure of about 40 large pages showing a large number of water supply, purification and pumping plants, sewage treatment installations and incinerators in which Westinghouse equipment is installed. Lots of striking pictures, but little text. Published by Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and we believe available on request.

Raw Sewage Pumps:

Buffalo non-clogging raw sewage pumps, in capacities ranging from 500 to 4800 gallons per minute, are described in a 16-page bulletin just issued by Buffalo Pumps, Inc., Buffalo, N. Y. Some dimensions are given.

Complete Power Pump Catalog:

Sludge pumps, road pumps for the highway builder, self-priming centrifugal pumps, drainage pumps, diaphragm pumps and double acting force pumps are all illustrated and described in a catalog issued by the Barnes Manufacturing Co., Mansfield, O. Worth a place in the engineer's file.

Enduro Steel and Corrosion Resistance:

A 16-page booklet covering the properties of Enduro steel has been issued by the Republic Steel Corp. A valuable feature of this booklet is the table listing the degree of corrosion-resistance of each type of this stainless steel to more than 300 chemical reagents, solutions and products under varying conditions of temperature and concentration. Write L. S. Hamaker, Republic Steel Corp., Massillon, O., asking for Bulletin 125, or write the Editor of this magazine.

Link-Belt Catalog:

A general catalog of 1024 pages, with list prices, has been published by Link-Belt Co., Chicago, Philadelphia, and San Francisco. It covers elevating and conveying machinery drive units, car dumpers, sand and gravel plants, coal and ash handling machinery, and the many other items in the Link Belt line. Valuable as a reference.

The Municipal Year Book, 1934

Clarence E. Ridley and Orin F. Nolting Editors, 256 pp., Cloth, Price $4.

Just published, the Municipal Year Book 1934 is the first edition of a Year Book for American cities—the only publication of its kind in the United States with up-to-date information and constructive opinion on the trends in municipal government. The first section contains five comprehensive articles covering the fields of major interest in 1933, and twenty articles by leading authorities giving a résumé of the significant events and developments in 1933 in the different fields of municipal activity.

The second major section of the Year Book contains data on the form of government in over 600 cities, including the type of government, type of election for councilmen, number of councilmen, whether elected by wards or at large, term of councilmen, salary of councilmen, and term and salary of mayor. Another table gives data on boards and commissions in each of 248 cities of over thirty thousand. This material is followed by financial statistics of cities, showing receipts, expenditures, debt, assessed valuation, and delinquent taxes, expenditures for unemployment relief, debt service, repayment of current borrowings, operation and maintenance, capital outlay, and total expenditures. Still other tables give information on the gross and net bonded debt, debt of schools and utilities, special assessment net debt, bonds sold and redeemed in 1933, and total unfunded debt.

The directory of city officials includes the names of mayors, city managers, and fifteen department heads in 310 cities of over thirty thousand and in over three hundred council-manager cities of less than thirty thousand. This section shows the number of years of service of these officials, whether elected or appointed, an analysis of salary trends since 1930, and average salary of officials in each population group as of January 1, 1934.

The third major section of the Year Book contains a selected list of the more important books, pamphlets, and reports published in 1933 or early 1934 in each of the fields of municipal activity. This section also contains a list of the more important periodicals in the municipal field.

The Year Book was prepared as a reference volume for mayors, city managers, finance officers, department heads, librarians, students of government, and others who are trying to keep municipal-wise.